BUREAU OF STANDARDS

DEC - 3 1921

THE TECH ENGINEERING NEWS

(See Page 143)

DECEMBER 1921

VOL. II NO. 6

The WORLD'S WORD for ELEVATOR SAFETY

The WORLD'S WORD for ELEVATOR SAFETY

PILAR INCLINE
CITY OF BAHIA, BRAZIL

BAHIA is divided into an Upper and a Lower City. One section is on the top of a cliff—the other extends between the foot of the cliff and the waterfront.

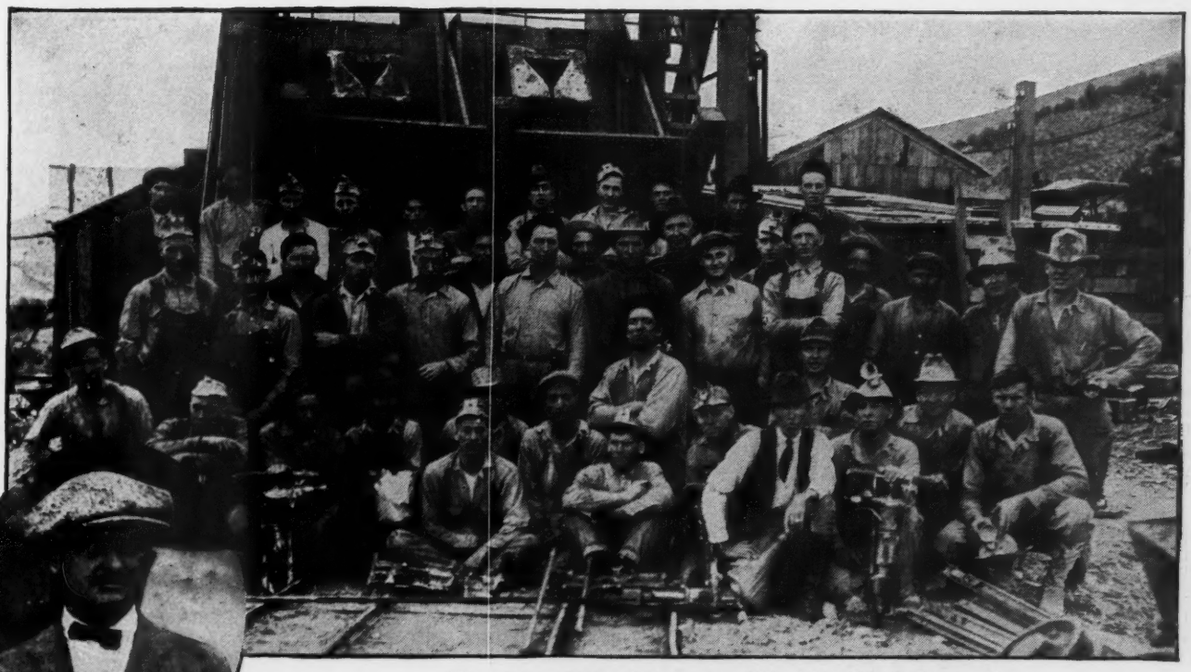
Four Otis Electric Elevators in two large vertical towers and the Otis Incline Railway pictured here, carry the people and freight up and down the cliff. The Incline Railway is built at an angle of 40 degrees; there are two cars working alternately, each with a capacity of 20 people and 1500 pounds freight and the trip is made in 90 seconds.

Otis engineering has successfully linked these two parts of Bahia. This achievement, big as it is, is but one significant detail of the world-wide service given by Otis.

Most of the famous structures of the world are equipped with Otis Elevators.

OTIS ELEVATOR COMPANY

Offices in all Principal Cities of the World



The Men Who Made the World's Shaft Record

J. D. Matheson, General Foreman (fourth from right in front row, kneeling), attributes the success of this undertaking largely to the efficiency of these men.

WALTER FITCH, JR.
President Walter Fitch, Jr. Co.

Another World's Record

The Same Contractor - Walter Fitch, Jr. Co.
The Same Powder - - Hercules
The New Shaft Record 427½ Feet in 31 Days

In 1916, Walter Fitch, Jr., Co. sank a shaft 261 feet in 31 days for the Chief Consolidated Mining Co., Eureka, Utah, a world's record at that time.

Hercules Dynamite was used.

On August 15, 1921, the same contracting company, sinking another shaft for the same mining company, completed a record of 427½ feet in 31 days. This exceeds, by 117½ feet, the best previous distance ever made.

Again, all of the dynamite used was Hercules.

What greater confidence in the reliability of Hercules Dynamite could be shown? What better demonstration of its performance?

The Fitch Company's continued choice of Hercules for this undertaking, which demanded the utmost efficiency from men and materials, is a significant fact worth remembering.

Write for our book—Hercules Products.

Condensed Data

Size of Shaft—5'9"x15'6"(outside dimensions)
Distance Sunk—427½ feet in 31 days.
Explosives Used—Hercules Gelatin L. F. 35%—1"x8"
Blasting Caps Used—Hercules No. 8
Average Dynamite Consumption per foot—15¼ lbs.
Average Footage per day—13.8 feet
Labor—Average of 5.7 shaftsmen per shift.
Drilling—Average of 23.9 holes drilled per round. Three rounds drilled per 24 hours.
Hoisting—Average of 72½ buckets of 17 cu. ft. capacity hoisted per shift.
Timbering—Average of 2.8 sets per day by an average of 4.8 timbermen.
Nature of rock—Porphyry and close grained limestone.
Total Delay During Month—13 hours due to failure of power and repairing head frame.

HERCULES POWDER CO.

Allentown, Pa.
Birmingham, Ala.
Buffalo, N.Y.
Chattanooga, Tenn.
Chicago, Ill.
Denver, Col.
Duluth, Minn.
Hazleton, Pa.
Huntington, W. Va.
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Los Angeles, Cal.
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New York City
Norristown, Pa.
Pittsburg, Kansas
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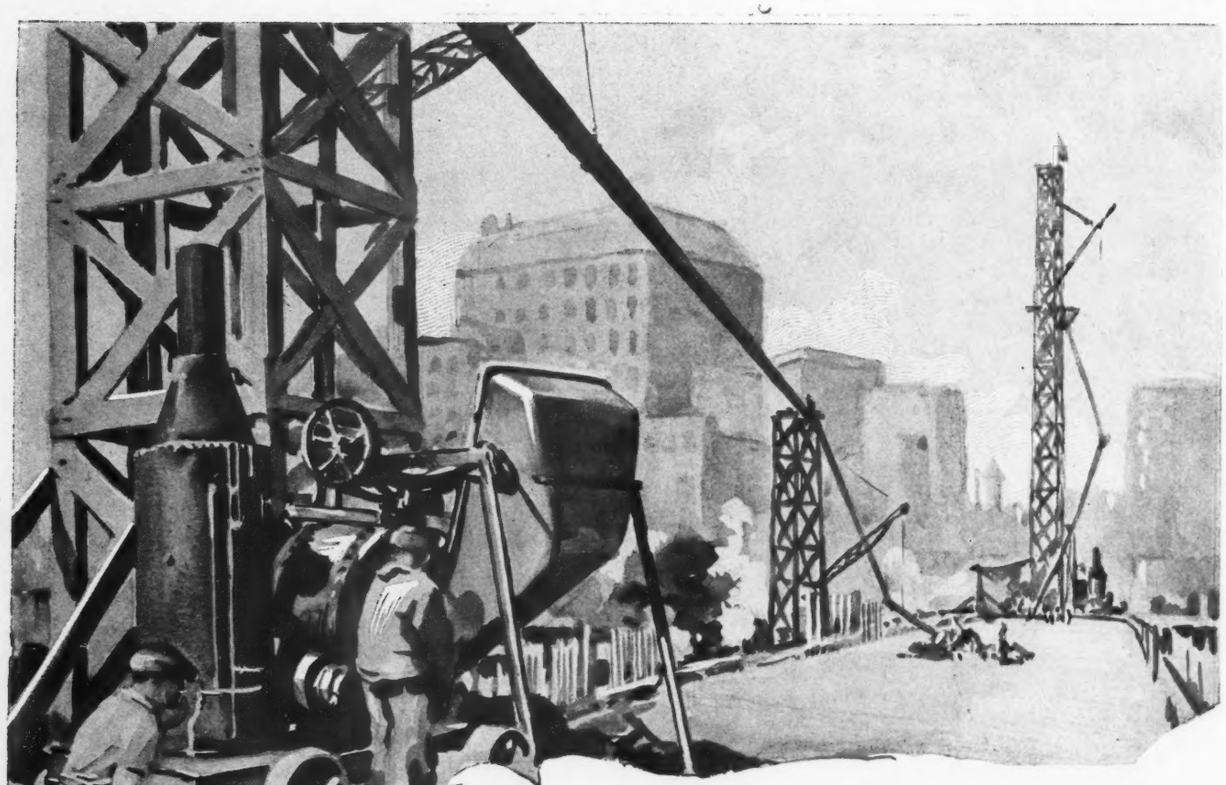
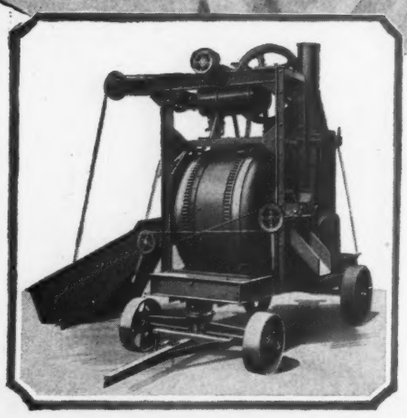
Pottsville, Pa.
St. Louis, Mo.
Salt Lake City, Utah
San Francisco, Cal.
Wilkesbarre, Pa.
Wilmington, Del.





Speed Versus Permanence

ON May 25, 1919, the Second U. S. Engineers constructed a 1440 foot span pontoon bridge across the Rhine at Honnigen in the record-breaking time of 58½ minutes.

In wartime bridge building the impelling necessity is speed. To get troops and equipment from one side of a stream to the other as quickly as possible is the vital need.

Permanent bridge building requirements are different. Durability and time both are dominating factors. Because the bridge must be substantial, safe, enduring, the reinforced concrete bridge most completely fills these requirements.

The Koehring Heavy Duty Construction Mixer is used in constructing these built-to-endure bridges in all parts of the country. Dominant Strength Concrete, 31 percent stronger than ordinary concrete, which is produced by the exclusive re-mixing action of the Koehring drum, guarantees the maximum safety and strength.

KOEHRING COMPANY
Manufacturers of Concrete Mixers and Locomotive Cranes.
MILWAUKEE WISCONSIN

KOEHRING

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MODERN PLACER MINING

By PROF. ROBERT H. RICHARDS, '68

Professor Emeritus of Mining Engineering and Metallurgy, Massachusetts Institute of Technology

Gold is present in nearly all gravel deposits, but the quantity of it is only sufficient to pay for its extraction where the gravel has been derived from hills or mountains carrying gold bearing veins, which in general are of sufficient richness to be worked successfully by mining.

The gravel is brought down from the hills, after being cut loose from the rock by frost and thaw, by rains, cloud bursts, floods, and glaciers. It is found in estuaries of rivers where the water has spread out over the plains, also in river beds of modern or ancient date, often in terraces on the sides of river banks which may be elevated much above the present level of the river.

It was first worked by the miner's gold pan, then by the cradle, the long tom, the sluice with riffles in it. The latter process, known as hydraulicking, was operated on an immense scale in the early days in California until serious results were caused by the quantities of sand carried down to the farms and ranches on the lower plains. The owners found the rivers being filled with sand and the land being flooded and ruined. Then came the lawsuits which eventually closed down the hydraulicking work. The farmers won, but only to find that the stopping in the state of a production of $9,000,000 annually in gold caused a business depression which was very serious indeed.

The gold dredging plant was then conceived and developed to its present state of efficiency. It is to describe the modern gold dredge that this article is written. If the prospecting and dredging is briefly described for one district, for example, Marysville, California, it will give a fair idea of how it is done in other districts.

Prospecting is done by laying out and sinking holes about 200 feet apart. The holes are drilled by a churn drill with a four inch pipe lining for the hole. After sufficient advance has been made a sand pump tube is lowered, and churned up and down, and the sand is hoisted out, and drilling continued. Fig. 1 shows a drilling plant. Each haul of the sand pump is turned over to a Chinaman with his cradle, and he extracts from it all the gold that dredging can get.

The cradle is a little table with rockers under it like the rockers of a baby's cradle. The Chinaman feeds the gravel on to the screen and removes coarse pebbles larger than ⅜ inch, allowing the fine sand to go down and be treated on the table. This slopes enough to cause the sand to travel slowly towards the discharge end, while the gold remains behind. The sand remaining on the table is swept back to the upper end. The rocking is repeated, and a second catch of gold is obtained. This is repeated until no more gold is obtained. The gravel is measured in a one cubic foot box, and the gold is weighed and reported as so many cents per cubic yard. This record is kept for every haul of the sand pump until the bottom of the hole is reached. Similar records are kept for all the bore holes, and they tell the manager where the good ground is and where the ground is too poor to dredge.

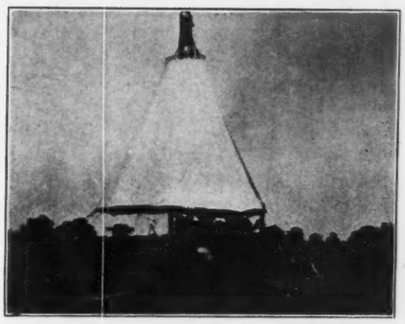


FIG. 1.—DRILLING PLANT
Prospecting is done by drilling holes and measuring the amount of gold per cubic yard found.

The dredge is shown in the diagram view in Fig. 2. Bo, is the boat which is divided at the bow end with an open space between the two parts where the chain bucket elevator and digger, C, can operate. Gy, is the gantry, or derrick frame, for operating the digger by rope pulley tackle, RP. The pivot, P, holds the upper end of the digger in place while the lower end can be swung for the requirements of the digging. The screen, Sc, receives the gravel. It has holes ⅜ inch in diameter, and revolves slowly, discharging the large pebbles on the stacker, St, which in turn delivers all the coarse portion on the waste gravel heap, Wg. The fine sand passes through the screen and goes to the gold catching tables, T, of which there are twelve or more. Half of them carry the sand towards the starboard side of the boat, and half towards the port side. The tables may have on their surfaces cocoa matting and expanded metal which are very efficient for catching the gold. The spent sand is discharged into the two launders, L, which also have the cocoa matting and expanded metal, and deliver the fine sand, F, well away from the stern of the boat. The boat is eighty feet long and forty feet wide.

The pit or pond is first dug, and the boat may be either built in it or launched into it when it has been filled with water.

The digging is done by a chain of buckets (see Fig. 3) which is slowly moved forward so that each new bucket will find new gravel to lift. The guiding of the dredge is important and is of two kinds; (1), to avoid portions of the prop-

(*Continued on Page 155*)

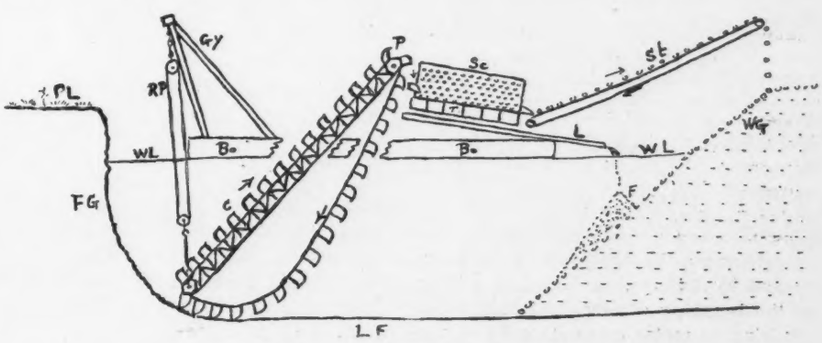


FIG. 2.—DIAGRAM VIEW OF DREDGE
The dredge is the modern machine for working gold-bearing sands.

SAFETY IN THE EVAPORATION OF VOLATILE SOLVENTS

By PROF. W. K. LEWIS, '05

Professor of Chemical Engineering, Massachusetts Institute of Technology

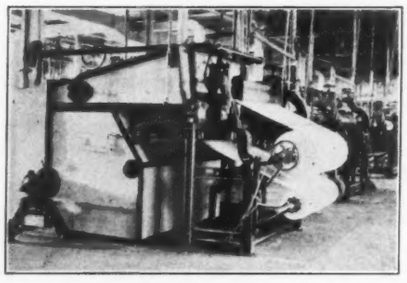
Volatile solvents are widely used in the impregnation and coating of fabrics as, for example, in the application of rubber cements to tire fabrics and rubber sheeting; in the manufacture of cellulose nitrate and acetate "dopes" for artificial leather and aeroplane wings; in waterproofing processes involving impregnation with bituminous and other compounds; and in many similar cases. They are also used in lacquers, varnishes and enamels. They are employed in the production of plastics, such as celluloid, artificial silks, rubber dipped goods, and smokeless powders. They are used in dry cleaning and grease extraction processes. In all of these cases the solvent must be evaporated, and it is proposed to point out the dangers inherent in this evaporation, and the best methods so far developed for eliminating them.

The important solvents are gasoline, kerosene, benzene, toluene, methyl-, ethyl-, amyl-, butyl-, and isopropyl alcohols, ether, acetone, various esters, carbon bisulfide, carbon tetrachloride, and various chlorinated hydrocarbons. All of these except those rich in chlorine are highly inflammable, and some of them are toxic. Carbon tetrachloride and all the highly chlorinated hydrocarbons are absolutely non-inflammable, but are expensive, and are subject to slow hydrolysis in contact with water, resulting in acidity and corrosion. Each solvent has its particular limits of inflammability when its vapor is mixed with air. If insufficient solvent is present a flame will not propagate itself in the air-vapor mixture because, if ignited at a given point, insufficient heat is generated there to raise the surrounding mixture to the ignition temperature. If, however, an excessive amount of vapor be present, the flame is smothered, partly due to the high heat capacity of the vapor, but largely because of insufficient oxygen. This results in combustion mainly to carbon monoxide, with evolution of a much smaller quantity of heat. These limits are illustrated by the following table:

	(Percent by volume)	
Vapor	Lower Limit	Upper Limit
Ether	1.6	7.5
Alcohol	3.7	13.6
Benzene	1.4	6.3
Pentane	1.3	4.8
Motor Gasoline	0.7	

Ignition may be due to static discharge caused by friction, to defective wiring, to the breaking of electrical circuits, to sparking on motor commutators and various other electrical causes; or to carelessness on the part of operators in the use of matches; to impact sparks and the like. When solvents are used out of doors, as in varnishes and the like, dilution is usually so great that explosions never occur and fires are rare and usually localized. Indoors, however, explosions are not infrequent and fires represent a serious industrial hazard.

The vapors of these solvents are toxic if inhaled in large amounts. Most of them produce dizziness and unconsciousness, but fortunately only a few of them, notably benzene and methyl alcohol, have serious toxic effects when inhaled in small quantities. All of them, however, when inhaled in noticeable quantity interfere sufficiently with health to result in minor discomfort, reduced effort, poor workmanship, and high labor turnover.



EVAPORATOR HOOD

The fabric from the top roll is coated with dope at the entrance to the hood, and after drying is rewound on the lower roll.

The solution of the problem has been attempted along two lines,—dilution with a large amount of air, and evaporation in an enclosed space.

It has already been pointed out that where evaporation takes place out of doors natural dilution is satisfactory. Indoors, however, the disadvantages of this method are serious. In the first place it is difficult to ventilate a room in such a way as to entirely eliminate air pockets. In such air pockets vapor concentrations can rise to the explosive point, and serious results may follow despite the fact that the room as a whole is properly ventilated. In the second place an extremely large amount of ventilating air is required, both to serve as a factor of safety in preventing pockets, and because of the fact that the explosive limits for the cheaper and more important solvents are so low. In the case of the more toxic solvents such as benzene and methyl alcohol, still greater dilution is demanded. This necessity for excessive ventilation results in a large waste of heat in cold weather and makes it almost impossible to recover the solvent vapors from the air.

In case dilution is employed, the ventilating system must be designed with great care to produce an even distribution of air throughout the room so that pockets will not develop, and to supply at all times an air volume sufficient to provide for the maximum instantaneous evolution of solvent vapor. This air supply must be at least three to five times that corresponding to the lower explosive limit, as otherwise under the best conditions localized concentrations of vapor may reach the danger point. The ventilation must not be natural, but forced, because natural ventilation, however good, is subject to weather conditions, and consequently to occasional failure. One of the worst fires with which the writer has had experience, occurred due to failure of natural ventilation. The vapor escaping into the room was so slight that under no conditions had it become noticeable, yet on a still, muggy night the ventilation ceased to function to such an extent that a bad vapor fire resulted.

All of these vapors are heavier than air. Furthermore, at the point where vaporization takes place, the air is usually cooled due to the absorption of the heat of vaporization. Consequently the air-vapor mixture formed is heavier than the air of the room so that ventilation should always be downward,—fresh air entering at the top of the room and withdrawn at the bottom, thus reducing to a minimum the mixing of vapor with the air of the room as a whole.

Where vapors are evolved from a table over which an operative must work, the vapor should always be drawn, not from above through a cone-shaped hood over the table, but from the back of the table at the side opposite from the operator. The cover over the table may flare upward if necessary to give more operating space. In this way all the ventilating air flows past the operative, and drags the vapors away from him, backward and downward as they naturally tend to go.

The ventilating ducts leading the air away from such a room represent a grave danger, especially in the case of high boiling solvents. The vapor concentration of the air leaving the point of evaporation may be quite high, and the temperature sufficient to keep the material vaporized. However, this air becomes diluted with colder air from the room, resulting in deposition of liquid solvents. These solvent droplets collect on the walls of the ventilating flues, and are likely to result in serious fires, and occasionally explosions. Where possible, the flues should lead downward to assist in the removal of this condensed liquid. They should be provided with explosion vents and cleaning doors, conveniently

located. Where the amount of condensed solvent is large it may be necessary to provide traps for removal of the liquid.

In any event such measures diminish but do not entirely eliminate the evil. This is controlled only by having the evaporation proceed in an enclosed space. This cannot be done in all cases, e. g., in the use of rubber cement in repair work, and in many other cementing jobs around a rubber plant. It can, however, be done much more frequently than is realized, and where practicable, it is by far the best solution of the difficulty. It makes possible more accurate control of drying conditions, resulting in greater production and more uniform product. It eliminates fumes from the workroom, and therefore reduces to an extremely low point the danger of toxicity. It also makes it possible to recover a large fraction of the solvent used.

However, certain disadvantages are claimed to result. These are, first the danger of fire and explosion, the latter being more serious because of an enclosed space; second, interference with production because of inaccessibility of work to the operative; and third, decrease in drying rate and completeness of evaporation.

It is true that evaporation in an enclosed space in the presence of air is extremely dangerous. A number of plants have operated in this way by attempting to keep the vapor concentration at all times above the upper explosive limit. Theoretically this makes an explosion impossible, but the danger of getting it in the explosive range by mistake is obvious. Indeed it is almost impossible to avoid. A more satisfactory method is to evaporate under a vacuum. This involves, however, extremely heavy and expensive equipment and devices for introducing and removing the stock from the evacuated space. Furthermore, it is almost impossible to control the drying operation. The worst solvent fire which the writer has investigated was caused by the removal of an incompletely dried roll of goods from such an apparatus.

The dangers due to the presence of air, and the operating difficulties due to the use of a vacuum can both be eliminated by evaporation or drying in the presence of oxygen-free gas. Carbon dioxide, sulfur dioxide, and nitrogen have been employed in the past, but, while efficacious, have been prohibitive in cost. During the last few years flue gas has been introduced for this purpose and has been found cheap and satisfactory, while at the same time eliminating the danger.

It is obvious that equipment of this sort interferes with production in that the operative cannot so readily get at the work as when evaporation takes place in the open air. On the other hand if the enclosing hood is made accessible by liberal provision of doors and removable top, if windows and vapor proof lights are inserted to make inspection easy, and if proper attention is paid to the design of the rolls, or other equipment used for conducting the stock through the drier, it is found in actual practice that the gain due to better control of evaporation, to freedom from occasional fires, and to increased comfort on the part of the operatives, has increased production and cut down labor turnover.

As to drying rate, it is admitted that such a system would be expensive if, in order to get complete drying, it be necessary to maintain throughout the evaporating equipment exceedingly low percentage concentrations of vapor. It is, however, doubtful if such conditions really exist. Usually, evaporation can be made to proceed more rapidly, and under better control by the use of high vapor concentrations at the point where the stock enters the equipment. This makes it possible to dry the stock with a small amount of inert gas. In one plant it has proven possible to secure an evaporation of a gallon of gasoline by the use of the flue gas produced from the combustion of a third of a pound of coke, and yet have complete drying from thin films in from three to five minutes, a production 70% greater than that previously realized in open air drying. Where air leakage into the equipment is small, and where the solvent is recovered from the gas leaving the apparatus, one may recirculate a large amount of the waste gas, thereby still further decreasing the amount of gas used for the evaporating process.

It will perhaps be helpful to those interested, to outline in some detail the conditions that must be met in designing the equipment for such an installation.

Most hydrocarbons will not explode when mixed with a gas which contains less than twelve per cent of oxygen. It is therefore unnecessary to have the gas absolutely oxygen free. It is good practice to keep the oxygen content at every point in the apparatus below 6%. There is no difficulty whatever in operating continuously with concentrations between 3% and 4%, even where there is considerable air leakage into the apparatus. Where such air leakage occurs it is obvious that enough flue gas must be employed to dilute it down below the danger point.

On a small scale the gas is best made in a special oil burner, although a gas producer may be employed. Where large quantities of gas are required, one should employ a special boiler with a dutch oven type of grate, using an unusually large grate area, and with the whole boiler setting enclosed in air tight, boiler steel, casing. The fuel employed should be coke, because this produces no tar and a minimum of dust. The fuel consumed per square foot of grate area should be low (not exceeding 7 lbs. per hour), because a high fuel rate tends to produce blow holes and inequalities in the fuel bed resulting in oxygen in the flue gas, and because the high gas velocity through the fuel bed, necessary to give a high combustion rate, carries dust and soot into the gas. The fuel bed should be deep (about two feet) to insure complete elimination of the oxygen. There should be ample combustion space above and beyond the fuel bed before the gases come in contact with the boiler in order to complete the combustion of any dust particles which may have gone into the gas. The gases must then

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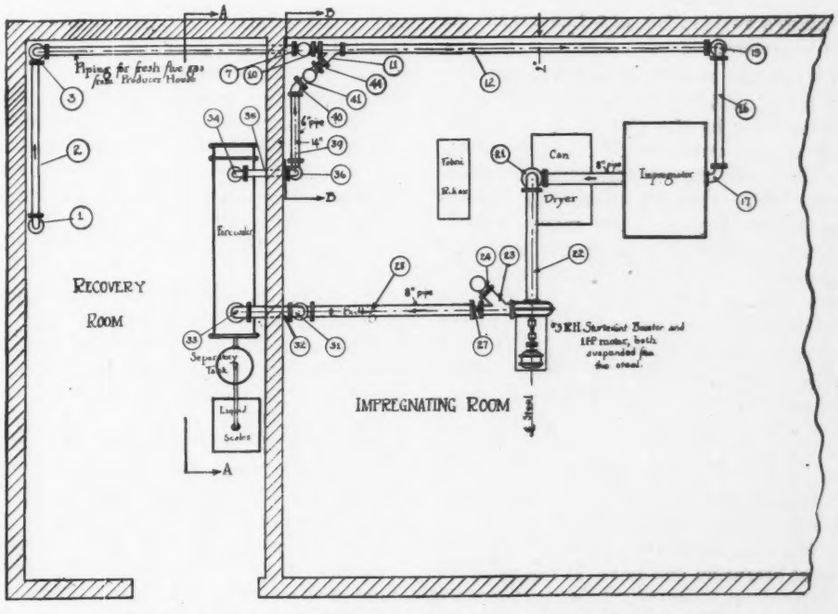

GROUND PLAN OF IMPREGNATION AND RECOVERY ROOMS

PROFESSOR EDWIN BIDWELL WILSON

By PROF. CHARLES L. NORTON, '93

Professor of Industrial Physics, Massachusetts Institute of Technology

Edwin Bidwell Wilson was born in Hartford, Connecticut, in 1879, and comes of old New England academic stock, his father and mother having been teachers in New England schools and colleges, and his brother being likewise engaged. He was graduated from Harvard at the head of his class in 1899 summa cum laude by virtue both of his general standing and of his attaining highest final honors in mathematics. Later he studied at Yale University, receiving a degree of Doctor of Philosophy there in 1901. Here he came under the influence of Dr. J. Willard Gibbs, under whom he specialized in mathematical physics and to whom he owes in large measure the inspiration for his subsequent work. After further study in France in 1902-1903 with Poincare, Boussinesq, Brillouin, Hadamard, and Le Chatelier to fit himself to teach Mathematical Physics at Yale under Gibbs, he returned to find himself obliged to teach not under Gibbs but in the place of that master who had recently died.

In 1907 he was called to Technology and remained a member of the mathematical staff until in 1917 when he was appointed Professor of Mathematical Physics in charge of the Department of Physics to succeed the late Professor Charles R. Cross. Since Professor Peabody's resignation as head of the Department of Naval Architecture and Marine Engineering he has had charge also of the instruction in Aeronautics in which he was actively engaged all through the war. Dr. Wilson has been a member of the Administrative Committee since Dr. Walker's resignation and has served as its secretary.

A brilliant student of mathematics who was attracted by the application quite as much as by the philosophy of mathematics, he devoted much time and energy to the study of those mathematical problems which concern themselves particularly with physics. His many publications deal largely with the mathematical treatment of physical problems and theories and of Economics. It is perhaps interesting just now in the midst of the renewed Einstein enthusiasm to recall a paper "On the Principle of Relativity" by Dr. Wilson in the Philosophical Magazine of thirteen years ago. I believe some early lectures given by Dr. Wilson in 1913 on the new Einstein Theory of Gravitation were the first public lectures on this subject in America.

His publications which have attracted most attention and have, in the minds of many of us, been most important, are the recent papers on aerodynamic problems, particularly the discussion of the "Theory of an Aeroplane Encountering Gusts" published in the Proceedings of the National Academy of Science in 1916 and 1917, where for the first time in public print were given calculations and curves showing the effect of certain types of gusts on an airplane in flight. Before and during the war his contributions to the science of aeronautics were of the greatest importance and he rendered to the government great service in this field both as a teacher and a physicist. He was actively interested in the formation

EDWIN BIDWELL WILSON

and maintenance of the school of aeronautical engineering for the officers of the U. S. Army and Navy in which they were taught the principles of aerodynamics and airplane design. His connection with the National Research Council and the National Advisory Committee on Aeronautics made it possible for him to bring about most effective contact between theory, experiment, and practical application.

Dr. Wilson is a member and has been Vice-President of the American Mathematical Society, a member of the Council of the American Philosophical Society, a member of the National Academy of Sciences (Section of Physics), of the Physics Section of the National Research Council as a representative of the American Physical Society and a Foreign Honorary Member of the Mathematical Society of Benares. He has been further identified with the American Mathematical Society of whose Transactions he was editor for a dozen years and with the National Academy of Sciences of whose Proceedings he has been managing editor since 1914.

Dr. Wilson's books are: Vector Analysis (1901), Advanced Calculus (1912), and Aeronautics (1920).

It is not only because of his mastery of his subject but because of his understanding of human nature, especially the nature of young men, that Dr. Wilson's teaching has been so eminently successful. With an unusually wide range of knowledge of every-day matters common outside the class room to teacher and student, with a keen sense of humor, he is an interesting and inspiring teacher of subjects frequently found dull and difficult.

As secretary of the Administrative Committee of which Dr. Talbot and Professor Miller are the other faculty members, Dr. Wilson has rendered with them great service to Technology through the trying times since Dr. Maclaurin's death.

The Norwegian Expedition to Nova Zembla, headed by Prof. Holtedahl of the University of Christiana, has returned, after explorations lasting two months, with a mass of data. The main features of the geological structure of the range of mountains in Nova Zembla were ascertained; and traces of land vegetation and fresh water fish dating from the Devonian age were found, showing that the great North Atlantic mainland of the Devonian age once extended as far as Nova Zembla. Twelve ocean level marks subsequent to the glacial age were discovered, and sea shells were found up to heights of 250 yards above sea level. The expedition also made a large collection of animal life, including new species of birds and fresh water fish.

Wireless Handwriting Transmission has been effected through the recent invention of Professor Edouard Belin. The instruments by which the recording of the writing is accomplished are very similar to those by which photographs have been so successfully transmitted by telegraph in the United States.

Large Deposits of Coal have recently been discovered in Lorraine, near the Saar Basin; and surveys show that they contain approximately five billion tons, from which the French could extract about 10,000,000 tons a year.

Grand Opera by Wireless became an accomplished fact recently when a complete opera was sent broadcast over the country by radio telephone from a theatre in Chicago, where the Chicago Grand Opera Company was staging a performance. The results were highly successful, according to reports.

RECENT ADVANCES IN AERONAUTICAL ENGINEERING

By PROF. EDWARD P. WARNER, '17

Associate Professor of Aeronautical Engineering, Massachusetts Institute of Technology

The general public is prone to suppose at the present time that aeronautical engineering is in an almost quiescent state. The rapidity of development during the war has dulled their palate for any less spectacular advancement. An occasional notable achievement, however, such as the recent bombing of the German battleships, or Lieut. MacReady's great altitude flight, arouses again a lagging interest in aeronautical development. Although the engineering profession is, of course, more nearly in touch with aeronautical progress than are those who merely read the newspapers, the remarkable extent and rapidity of that progress nevertheless comes as a surprise even to some of those engaged in technical pursuits. Such progress has come in part, to be sure, in airplane design, but even to a larger extent in the invention and construction of accessories and components of the aircraft.

The progress of airplane design itself can best be summarized by a few contrasting performances. It is about twelve years since the Gordon-Bennett race for airplanes was first contested at Rheims, and was won by Glenn Curtiss at an average speed of 47 m.p.h. A pursuit machine making 135 m.p.h. was regarded as exceedingly fast even up to the time of the Armistice. Since then, however, speeds have been raised until 150 m.p.h. for a pursuit airplane is not out of the ordinary, and over 190 m.p.h. has been attained on numerous occasions. The making of altitude records is a spectacular field of the greatest military use, and here the improvement has been even more striking. In 1909, at about the same time that Curtiss was winning the Gordon-Bennett race, an altitude record was made by Hubert Latham which aroused great interest all over the world. Latham had piloted his airplane to a height of 490 feet. At the present time the record stands at 40,800 feet, and the end is by no means in sight.

While specialized airplanes have been making extraordinary records of speed and climbs, others have gone about the routine business of commercial operation, or of military service. If the development of aircraft in the last few years were to be summed up in a single sentence, it might be described as a development in the direction of constantly increasing specialization and differentiation of function. Airplanes in 1914, although very diverse in design, were nearly all planned for essentially the same purposes. In 1921 there is, if anything, less difference in design, but an infinitely wider range of specialized use. Together with increased specialization of use has come improvement in the direction of simplification, making for cheaper construction and easier maintenance, as well as for improved performance through decreased resistance. The airplane of 1914 had, on the average, fully twice as many wires and struts as the airplane of 1921. Indeed, some airplanes have been built in the last three years with no wires or struts of any sort, as shown in one of the photographs. Such a structure, having no adjustments and offering no possibility of misalignment, can be dismantled or re-erected in fifteen or twenty minutes, whereas the old type often required one or two days.

The development of so many different types of airplanes has necessitated a corresponding expansion of engine development. It is amusing now to recall that when one of the British pioneers offered his airplane to the War office about 1907 it was rejected because it had a 50 H. P. engine, and the official verdict was that if airplanes were to require such enormous powers they could never be of practical use. At the present time, 300 H. P. is the normal complement of a pursuit machine, and single-seater racing airplanes have carried engines of more than 500 H. P. on some occasions, while the development of 600 H. P. or more on a single crankshaft has become a commonplace in large aircraft. There are under development in various parts of the world at the present time, at least four engines designed to give 1000 H. P. on a single shaft. This development in power has been accompanied by a decrease in weight per horsepower until truly astonishing figures have been reached. A radial air-cooled engine has been built to give 450 H. P. continuously with a weight of 636 lbs., this being a weight of 1.41 lbs. per H. P.; and 2 lbs. per H. P. is considered quite ordinary for several types of engines. It is natural that such increase in power and reduction of weight should have led to the development of new types of engine, as it is hardly to be expected that the best results can be obtained for all sizes by directly copying the automobile engine. The more successful of the new types brought out are the W engine with three banks of cylinders in place of the two found in the common 8 and 12-cylinder cars; the radial, either air or water-cooled, with the cylinders arranged in star formation around the crankcase; and the X engine in which there are four banks projecting from the crank case at various points (not always uniformly spaced) around its periphery. The W engine has 12 or 18 cylinders, the X 16 or 24, and the radial from 7 to 28, the latter figure having been attained in a recent German design intended to develop 1000 H. P., and employing 56 spark-plugs and 112 inlet and exhaust valves.

A EUROPEAN COMMERCIAL AIRPLANE
This machine carries ten passengers, and is used on the Paris-London route.

More interesting than the power plants themselves, however, are the accessories that go with them, and particularly those recent inventions, the supercharger, the variable pitch propeller, and the leak-proof tank. The supercharger has come in answer to a need long recognized,—the need for some means of improving the performance of aircraft at high altitudes where much of their maneouvering and fighting was carried out in the last part of the war. The power given by an aircraft engine without supercharger normally falls off to one-fourth of its sea level value at a height of 40,000 feet. With the Moss supercharger as used in Lieut. MacReady's recent flight, it can be kept virtually constant. The supercharger consists essentially of a turbo-compressor driven by the exhaust gas at a very high speed (about 24,000 r. p. m.) which increases the pressure of the air furnished to the engine until it corresponds to sea level conditions. The problem is superficially a simple one, to be sure, but great mechanical difficulty has been encountered and the recent successful flights are the crown of over three years of steady work on the problem.

The story of the variable pitch propeller, like that of the supercharger, is one of patient effort applied to the development and perfection in detail of a relatively simple idea. It is well known that the propeller pitch required for maximum speed is considerably greater than that for best climbing performance, and numerous attempts have been made to secure some variable pitch device which would do for the airplane, what the gear-box does for the automobile. Such a propeller has finally been brought to the

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POWER FROM VOLCANIC STEAM

By UGO FUNAIOLI

Director of the Electrical Department, Societa Boracifero di Larderello, Italy

At Larderello, in the province of Pisa, Tuscany, not far from the ancient city of Volterra, are to be found several natural steam springs, evidently due to latent volcanic activity. These springs were the object of superstitious fear of the peasantry until 1790, when Paolo Mascagni, Professor of the University of Pisa, ascertained the presence of boric acid in the waters. The result of this important discovery was the birth of the well known boracic works currently described in all treatises of chemistry and geology.

The steam in the natural condition finds its way through crevices in the soil, sometimes issuing at the bottom of small craters filled with water (locally termed "lagoni"), but more often in jets of steam direct from the earth, called "soffioni." Besides steam these springs emit a certain percentage of gases, chiefly CO_2, N_2, and H_2S, together with some helium.

Although originally these springs were exploited for the recovery of the boric acid contained in them, in 1897, the natural steam was used to heat water in a boiler, and the pure steam so produced was employed for driving a small engine. Since then, power development has become by far the more important industry.

In accordance with the increasing need of more steam, as the power plant developed, wells have been bored, thus producing artificial "soffioni." These wells are lined with iron tubes, welded together with oxy-hydrogen flame to prevent collapse of the sides. Steam is generally found at a depth of about twenty meters, and the work from that point proceeds with increasing difficulty. When it is judged, by signs known to the practiced eye of the foreman, that the hole has reached a sufficient depth (usually from sixty to one hundred meters), a curious operation locally termed "sfulminazione" (explosion), is sometimes performed, in order to clear the interior of the hole of all remaining debris and of the water which balances the pressure of the steam. It is effected by introducing into the well a piston, which is withdrawn as rapidly as possible by means of an electric winch. This provokes a small volcanic eruption which sometimes smashes the wooden structure erected over the hole and distributes mud and stones over a considerable area. This lasts for some minutes, and is followed by the steady and continuous emission of dry steam. The highest pressures obtained are about three atmospheres effective, and the temperature of the steam is about 180 degrees centigrade.

Prince Ginori Conti, now chairman of the Societa Boracifera, experimented, in 1905, with the use of natural steam in a piston engine. The results were so satisfactory that a larger one was installed, and used for driving a dynamo. This engine has now been working for over ten years, and shows no signs of corrosion from the natural steam. A 250 kw turbo-generator was put up in 1912, but on account of doubt as to the manner in which the blades of the turbine might be affected by the gases, and because of the difficulty of obtaining a sufficient vacuum in the condenser due to uncondensable gases in the natural steam, it was decided to use the steam as a means of heating pure water in intermediate boilers. This unit was so successful, that in 1914 work was begun on three units of 2,500 kw each, but, interrupted by the war, they were not completed until 1916.

NATURAL STEAM SPRINGS
In the back-ground is a derrick used for boring wells.

The boilers, or more correctly speaking, evaporators, in the new plant, consist of aluminum tubes contained in a shell of sheet iron. The natural steam circulates outside the tubes, while pure steam is generated on the inside, on the principle of the ordinary water-tube boiler. Aluminum was adopted for the water tubes instead of iron or steel, because the sulphydric acid contained in the natural steam would form a layer of sulphide of iron on the exterior surface of the tubes, lowering thereby the coefficient of transmission of heat.

There are about 300 tubes in each element, which are about seven meters long, have a diameter of thirty millimeters, and are disposed vertically. Each evaporator element is calculated to produce about six thousand kilograms of pure steam per hour. Previous to entering the turbine, the pure steam is superheated, by means of natural steam, which passes through the superheater before reaching the evaporator elements.

The steam is generated by the evaporators at a pressure of half an atmosphere effective, a certain allowance is made for loss of pressure in the steam supply pipes, so that one-fourth of an atmosphere effective is the pressure regarded as available at the admission valves of the turbines.

Steam consumption being about fourteen kilograms per net kilo-watt hour, over 35,000 kilograms of steam pass into each turbine per hour, and the admission valve is made of ample dimensions for the purpose of dealing with such large amounts of low pressure steam. Each turbine itself is really composed of two turbines, the inlet for the steam being at the center. This device has the advantage of eliminating any longitudinal thrust, besides reducing the diameter of the turbine wheels. The turbines are entirely built on the reaction or Parsons type. Seven stages of expansion are allowed on each side of the rotor; the first five being fitted with brass blades and the remaining two with five per cent nickel steel blades.

The condenser is of the surface-cooling type, and contains about three thousand brass tubes of twenty-two millimeters diameter, and four and a half meters in length. A centrifugal pump directly coupled to an electric motor drives the cooling water through the tubes, and sends it on to the refrigerating tower. Each pump requires about three hundred horsepower.

Instead of air pumps, two hydraulic ejectors are installed below the condenser, the cool water from the refrigerator tank arriving at the ejectors and passing on to the centrifugal pumps. Special attention has been paid to all details connected with the condensing plant because the output of the turbines depends mainly on the efficiency of the vacuum obtained in the condenser; the admission pressure of the steam being, as stated above, only one-fourth atmosphere.

The cooling water is sent on to the refrigerating towers through an iron pipe about nine hundred millimeters in diameter. The refrigerating towers have a capacity of twelve hundred cubic meters per hour; and are naturally of ample dimensions, being of natural draught type. Two of these towers are in use, while a third is being erected. The structures are entirely of wood, while the reservoir under each tower is made of reinforced concrete. The towers are about twenty-five meters high, six and a half

meters of which are actually occupied by cooling structure, the rest being the flue for the natural draught. The reservoirs are thirty meters long, and eighteen meters wide. The fall in temperature given by the towers is about ten degrees centigrade.

The alternators, which are three-phase, 50-cycle at 3,000 r.p.m., are coupled directly to the turbines. The exciting dynamos are co-axial with the alternators. It is also possible to excite any of the alternators by means of a rotary converter. Each of the alternators is provided with an air filter, the use of which has proved very beneficial.

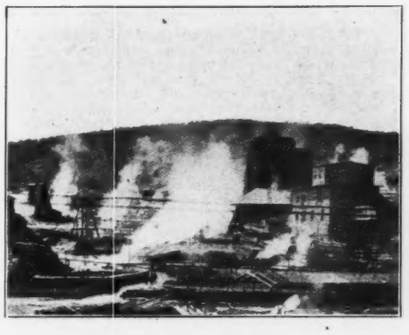
The connections between the alternators and the switchboard consist of aluminum bars running in a special gallery under the terrace leading to the generating station. The switch-board itself is of a very simple type, and contains only the essential apparatus for controlling the alternators, and running them in parallel.

The step-up transformers for raising the voltage from 4,000 to 36,000 are placed in an adjoining building containing also the high and low tension switches, and the lightning arresters. They are all of the self-cooling oil type, and the high tension range is from 32,000 to 40,000 volts. Another smaller transformer station is provided for raising the tension from 4,000 volts to 16,000 volts for distribution in the region around Larderello. These minor lines connect the various works, and convey power as far as Volterra.

As yet but two of the 2,500 kw turbo-alternators are used, one of the three installed being kept in reserve. It is expected that in a short time 5,000 kw will be distributed, and steps are being taken for the erection of a fourth group, so that three turbines may be run, giving 7,500 kw. Further experiments are also in progress for utilising direct natural steam in the turbines. This idea, which had been abandoned in the case of the Larderello plant, has been taken up again in another of the society's works at Lago. In that locality a notable quantity of natural steam is available, and the nature of the soil is specially favorable for perforation. A steam well at Larderello often takes more than five or six months of continuous work before it is ready for use, while at Lago three or four months may be sufficient, and in some cases even less, the well being ready for explosion at a smaller depth than at Larderello.

Besides this, recent accurate measurements and experiments have proved that the quantity of gas contained in the steam at Lago is notably less than at Larderello, the latter being five per cent in weight, while the former is only about three per cent. Thus one of the difficulties which forbade the use of direct natural steam, i. e., the presence of gas to be removed from the condenser, would be in part eliminated. As to the action of the gas on the turbine blades, experience at Larderello has shown that it is certainly not of paramount importance, if the right qualities of metal be used, and certain precautions taken.

With regard to the extraction of the gases from the condenser, air pumps would have to be provided in adequate proportions to the gas itself, and while these would, of course, require a certain amount of driving power (lessening thereby the output of the turbines), on the other hand the abolition of the evaporators would increase the total efficiency of the system. Jet, instead of surface, condensers could also be used, thereby reducing the cost of the whole plant, a further noticeable reduction being obtained by the abolition of the evaporators. Following these considerations, an experimental plant has just been completed at Lago, by installing there the small turbine of 250 kw first used at Larderello.



GENERAL VIEW OF THE PLANT
On the right are the cooling towers and transformer station.

Signor Plinio Bringhenti, engineer of the society, who studied the Larderello plant, is experimenting at Lago with a new type of separator invented by him for eliminating gas from natural steam, before it enters the turbine. If these experiments give the result that is hoped for from them, a decisive step will have been taken towards the rational and complete solution of the problem. Designs are being got out for the erection of a much larger plant at Lago, capable of developing over 10,000 kw.

The present condition of Italy with regard to fuel is well known. For the industrial developments of that country, all natural sources of energy must be turned to account. While the northern part of the Italian Peninsula is rich in water power, such is not the case in Tuscany, where the water courses from the Apennines are subject to long periods of drought. Lignite is used as a fuel in the large power station of the Societa Mineraria del Valdarno, and the distillation of peat at Orentano, near Lucca, produces gas which is utilized in gas motors. Natural gas springs also, near Pisa, are being used for the illumination of that town, and will be used for motive power.

Still the demand for electric power is steadily increasing, and the more complete utilization of the natural steam springs cannot fail to prove of the greatest importance for meeting this increasing demand. The courageous initiative of Prince Ginori Conti, who has worked steadily for years towards the solution of the problem of utilizing the natural steam springs, is therefore well worthy of praise. Following his initiative, other studies are also being made for the utilization of latent volcanic energy near Naples, at the famous Solfatara of Pozzuoli. No definite previsions can be made at present as to the further development of these systems, but one is certainly led to consider the probability that volcanic energies, hitherto only regarded as a source of danger, may, in the future, become beneficial factors in our national economy.

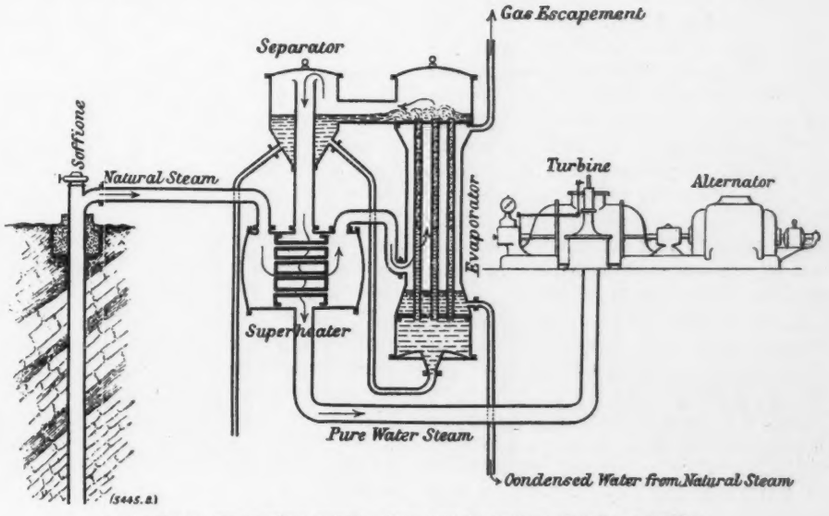


DIAGRAM SHOWING HOW THE VOLCANIC STEAM IS USED

CONDITIONS IN ARGENTINA TODAY

By WILLIAM F. BENKISER

Vice-President of The First National Bank of Boston

When the war broke out, the Argentine was one of the first countries to profit. It is chiefly an agricultural country. It has large herds of cattle, and about 75,000,000 sheep. Its wheat, its meat, its hides, its linseed, and its corn were among the first commodities to experience advances in prices, and although the country was obliged to make heavy remittances for interest on foreign capital invested, I venture to say that the net trade balance in her favor for the past five years has added at least $300,000,000 to her wealth.

The Argentine fundamentally is sound. In addition to its agricultural resources it is rich in raw materials, and reminds me very much of our own country. There are quebracho, tobacco, oil, sugar, and mica. Cotton is making satisfactory progress, with the Government's assistance. Nutria skins, used in ladies' fur coats, are exported in substantial quantities, and are one of the few articles not affected by the general depression. Coal of satisfactory quality so far has not been found, but indications are that there are deposits of gas coal in the Andes, which can be made available under improved transportation facilities.

Although comparatively little raw material left the country during the second half of last year, the situation was not grave, and the Government met it in part by permitting the Banco de la Nacion to loan to ranchers, commission houses, and exporters, on the wool and hides accumulating, for a term of two years. However, the month of August, 1920, added to the difficulties of the local producer and exporter the troubles of the importer. Europe evidently had spent its available cash and had used up the private credits granted her by us. The foreign markets for South American goods were becoming more and more limited, and an oversupply had made itself felt in the United States. One fine morning in August, 1920, news was cabled to certain Argentine representatives of North American textile manufacturers announcing reductions up to 30% on orders placed and in process of manufacture. This news went the rounds through commercial houses like wild-fire. Up to then the banks had had some minor difficulties in making collections for imports, owing to the rise in dollar exchange. Concessions had to be made either by contracting parties sharing the loss in exchange or by shippers granting an extension of time. The drawee frequently showed his good faith by depositing the dollar amount in pesos at the current rate of exchange as payment on account, for merchants and bankers believed that the country's wheat crop available for export would quickly re-establish the financial equilibrium.

The manufacturers responsible for these cables no doubt had in mind that a price reduction on goods in process of manufacture would retain orders for them against European or other North American competition when price reductions would become more general, but the effect on the Buenos Aires merchant was disastrous. The goods that had been taken and paid for during the month showed him immediate losses up to 50% and there was no telling where the bottom would be. I know that quite a lot of orders were cancelled promptly. At first reductions were asked on goods then arriving, but later on, when the situation grew worse, goods were rejected absolutely, some of them justly, others under mere pretext.

South America—the land of promise and opportunity—is an ever growing source of raw materials for the world. How has it been hit by the recent slump in business? Mr. Benkiser, an expert on the finances of the Argentine, answers this question from his own experience, and also gives some tips on our trading relations with this growing Republic.—Editor.

It would have been better, I feel, if we had waited for the Buenos Aires merchants to request reductions and adjustments in each case. The situation was aggravated by our having continued to accept orders exactly as during the war, although in many lines we had not made shipments within the time agreed, for we had preferred to supply the home market for a quicker turn, and dump in South America when this home market would no longer absorb. The armistice period had taught us no lesson.

I know of a case—I might say it is one of a few only—where merchandise arrived without previous notice, during December, which had been ordered two years before, and about which the Buenos Aires house had entirely forgotten. It was one of the very best houses, and after explaining the case to me with a sour smile, the bill was paid at the prices quoted two years ago; when this house might reasonably have taken the position that it was not obliged to accept the goods.

If we cannot learn that the foreign markets must be treated on the same basis as our home market, if we cannot set apart a certain percentage of our production for export for regular deliveries, I see little hope for the future of our foreign business. The Argentine merchant, when goods do not arrive within the time specified, is likely to give the same order to another house that may promise immediate delivery, feeling that in this way he may get at least a part of his order. This is how things were done during the war. When at last, the home market having slumped, everybody shipped, we had the crisis with which we have become familiar during the past three years, and both shipper and customer suffered.

American branch banks lent their assistance in trying to adjust difficulties, and I might say that for fully two months almost my entire time was occupied with conferences with shippers' representatives and Buenos Aires merchants. In flagrant cases in which our manufacturers had rigidly complied with requirements and where bad faith on the part of the customer was evident, if the latter was one of our borrowing customers we would ask for payment of his loan and the removal of his account. While the behavior of the Buenos Aires importer was in many cases subject to criticism, it should be realized that his action was inspired by the fact that the abnormal drop in prices, in addition to the exchange, spelled utter ruin for him. In a number of cases it was more advantageous for the manufacturer to take back his goods or make a very substantial reduction to save his customer, than to insist upon acceptance of the goods at the original prices and take a chance on what he might obtain out of bankruptcy.

I think we could work on a mutually more profitable and satisfactory basis by keeping in closer touch with our customers. A native representative is usually in close touch with his customers, but often does not keep his manufacturer well enough informed about the situation, and I may say that the manufacturer frequently does not guide the policy of his foreign sales representative, but is satisfied as long as orders come in.

We should not send men to the Argentine just because they can speak Spanish. We are up against the keenest competition from all of Europe and Japan. A number of the American concerns which have been in the Argentine for some time long ago appreciated the situation, and their organizations there make a noteworthy exception. Where business warrants it, a man from the home office, fully familiar with the scope of the plant and the policy of the management, and a native familiar with the trade make an ideal combination. I will not dwell upon the elasticity of the European manufacturer and the rigidness with which the American manufacturer, as a rule, has been insisting that foreign markets

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CIVIL ENGINEERING AND CIVILIZATION

By PROF. EDWARD H. ROCKWELL

Professor of Civil Engineering, Tufts College, Mass.

In his Seven Lamps of Architecture, Ruskin shows how every form of noble architecture is in some sort the embodiment of the polity, life, history, and religious faith of nations, and he asks the question, "How many pages of doubtful record might we not often spare for a few stones left one upon another?" for, as he says, there are but two strong conquerors of the forgetfulness of men, Poetry and Architecture.

As used up to the time of Ruskin, the term Architecture undoubtedly included all forms of engineering construction as it certainly did in the time of Vitruvius 2000 years ago.

It is commonly believed that engineering is a new profession. There are of course many branches of engineering that are quite new, such as Electrical Engineering and the scientific part of all engineering, but as an art, certain kinds of structural engineering have been practiced since civilization began. This must have been true for no material progress of any sort can occur without roads, aqueducts, dams, and bridges, and, indeed, there is abundant evidence that public works were planned and carried out on a scale comparable with those of the present, in both Egypt and Babylonia, long before historic times. The dense populations of both these countries, including great cities, were largely dependent on irrigation, and there is ample evidence of complete and satisfactory systems of canals including masonry dams and large reservoirs, which made ancient Babylonia the garden spot of the world, rich in agriculture and prosperous from commerce. It is recorded that Alexander the Great tried to use those canals to transport his army but was stopped by masonry dams. There is also evidence to show that the Nile River and the Red Sea were connected by a canal as early as 1450 B. C.

Even earlier than this, perhaps 5000 B. C., the Egyptians changed the course of the Nile by building a dam so that the river ran on the eastern side of the valley instead of the western, which made room to found a city, perhaps Memphis or Thebes, and served as a barrier to the warlike people of the east. Somewhat later the Egyptians built a great reservoir covering six or seven hundred square miles to store the waters of the Nile for the dry seasons.

Throughout what is now Mesopotamia they are today prospecting for oil on the sites of numberless ancient and populous cities in whose ruins are found the remains of immense palaces and temples. Here the material of construction was mostly brick, and the bricks of Babylon with their inscriptions are priceless books, telling the story of a highly developed civilization. These ancient peoples were familiar with mechanical principles, such as the lever, the inclined plane, and the pulley. They had sewerage systems, with brick arches twelve to fifteen feet in diameter, in the palaces. They were familiar with many astronomical facts, and may have used telescopes since a lens has been found, evidently ground on a lathe, and bearing the name of Sargon, an ancient ruler.

There were extensive quarries of fine

A VINE BRIDGE SPANNING A MEXICAN RIVER

granite and limestone in Egypt, and most of the ruins there are of these materials, the masonry being perfectly matched and laid without mortar. Most of the building construction of these ancient times was for the glory or gratification of the royal families, and great works were possible, without the modern mechanical aids of steam and electricity; because these rulers did not hesitate to use their despotic power to compel great numbers of men to work on these projects. Herodotus tells us that twenty thousand workers were employed in erecting a single obelisk in Egypt, and that many times that number were employed for years on the pyramids.

Enough has been said to show that Civil Engineering as an art is one of the oldest of the professions. But Civil Engineering was not known as such until late in the 18th century; because, until that time, engineering and architecture were one united profession. It is only about one hundred and thirty years since diversified interests and increasing scope have caused a separation into two professions.

The first and perhaps best definition of Civil Engineering was that written by Thomas Tredgold in 1828, and incorporated into the charter of the British Institute of Civil Engineers, where it has remained unchanged ever since. It is—"Civil Engineering is the art of directing the great sources of power in nature for the use and convenience of man—" The term Civil Engineering came into use because the word "civil" was used to differentiate its meaning from Military Engineering.

Although, having been practiced as an art for six or seven thousand years, it is only during the last century that the scientific and mathematical basis of Civil Engineering has been discovered and developed. For almost 99% of its lifetime Civil Engineering has been empirical and experimental. It has now also become scientific and rational, and, as such, economic; that is, it can now scientifically adjust the means to the end and make the cost commensurate with the service.

As early as 5000 B. C. the Egyptians had already accomplished in the Temple of Karnak an architectural feat of such magnitude that it has compelled the admiration and wonder of all succeeding generations. The main hall was 1200 by 420 feet, and in the chief hall of the temple some of the original 134 massive columns are still left. These columns were monoliths 70 feet high, 11 feet in diameter, and weighed nearly 500 tons each. They were all brought 500 miles down the Nile and put in place, a feat not easy to duplicate even with our machinery of today.

About a thousand years later, or about

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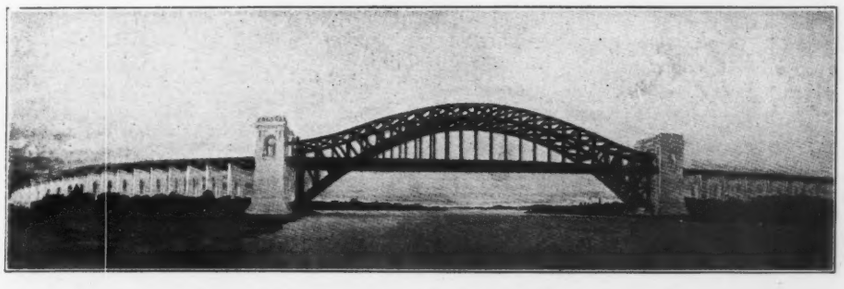


THE HELL GATE ARCH BRIDGE

This, the largest arch span in the world, represents the finest type of American bridge engineering.

STORAGE BATTERY LOCOMOTIVES IN MINES

By E. V. DAVELER, General Superintendent, and R. E. RENZ, Chief Electrician,

Butte and Superior Mining Company, Butte, Montana

The use of the storage battery locomotive for hauling in the metal mines of the west has been on the increase steadily from 1913 until the recent depression in the mining industry. The demand for more efficient operations in underground haulage has resulted in all operators giving very serious consideration to this phase of mining operations. The different methods of underground haulage may be classed as follows: hand tramming, mule tramming, and hauling by both trolley and by storage battery locomotives. Hand tramming and mule tramming will of course always have their own field when the tonnage from any one level is not sufficient to warrant the use of motor haulage. Hauling by trolley locomotive is well suited to long hauls underground where there is a large tonnage and ample head room, and where the ground is readily held in place. The storage battery locomotive has its particular field in that it can operate in drifts or haulage ways with a minimum of head room, can handle both large and small loads, and can easily be moved from one level to another when mining operations demand it. It can fit into any of the particular fields of the other common methods of underground haulage. In considering the applications of hauling with storage battery locomotives, the authors of this paper will consider especially mines in which they have had experience with them.

In the Butte and Superior Mining Company mine at Butte, Montana, underground haulage with storage battery locomotives has been very successful. The mine has been operated down to the 2,300 foot level, with mining operations carried on from the 800 to the 2,300 foot level in the last nine years. The ore bodies are very wide and the ground very heavy, causing a considerable shifting of the grade on the haulage levels and making it unfavorable to maintain economically a constant height of the haulage ways. Due to this condition all haulage ways are narrow and low.

In the early part of 1913 it became evident that, in order to deliver the required tonnage to the one shaft then operating, some form of power haulage was necessary. Hand tramming, due to the grade variations in the levels, had become very inefficient; in fact in some places it was impossible for trammers to push one loaded car. A study of the situation showed that trolley haulage was out of the question as the drifts were too low, and the upkeep on the trolley system under the mining conditions would be prohibitive. The low drifts made the trolley system very dangerous for workmen and the moving ground caused a liability of fire. The only method of electrical tramming left was the storage battery locomotive system, which at that time, early in 1913, was in the experimental stage. However, it was decided to try it out, and two Jeffrey storage battery locomotives were installed early in 1913, and two additional locomotives in 1914. On the type secured the chassis weighed 3½ tons, and the battery 1 ton. The locomotives were 11 feet long, 32 inches wide, with a 36 inch wheel base, and ran on an 18 inch gauge track. The draw bar pull was 1500 pounds. They were equipped with two sets of batteries, one to be used while the other was charging, giving continuous service for the locomotive. Each battery consisted of 63-A4 Edison cells having a capacity of 150 ampere hours and an average voltage of 75. The locomotives were equipped with two motors, each geared by means of worm gears to a separate set of drive wheels. With this construction it was possible to keep the maximum width down to 32 inches. The locomotives have a speed of 4 miles per hour, modern headlights with 94 watt focusing type lamps, and foot bells. The control is standard series-parallel control with resistance points between.

> We used to hear of the horseless age, but now we hear more and more about the electrical age. Just as in our cities the horse-cars have given way to the electric trolley, now the mules far below the surface of the earth in our mines are yielding to the electric storage battery locomotive.—Editor.

For a year the operations were perfectly satisfactory, but about this time it was discovered that in wet levels the storage battery cells would ground, and that, due to electrolysis, the steel containers were eaten away, causing leakage. This was due to insufficient insulation between cell and battery box, and was remedied by mounting the individual cells on porcelain blocks. This method of insulation is still in use, although the Edison Company has devised a method of insulation by rubber bushings which is apparently as satisfactory.

Early in 1917 the work required of the locomotives became very heavy, and it was necessary to change the A4 batteries before the shift was finished. These cells were then replaced with A6 cells with an ampere hour capacity of 225. The number of cells to a battery was increased from 63 to 66, and later to 72, which is the greatest kilowatt capacity that can be accommodated on the present type of motors. This has improved the efficiency of the locomotives materially, as the voltage at end of discharge holds up better, and greater loads at higher speeds can be handled.

One big advantage of the storage battery locomotives is their almost entire freedom from electrical troubles such as grounds and shorts in armatures and field coils. Due to the voltage being only 75 to 80 volts, there is very little danger from accidental contacts. As originally built, leads were connected to locomotives by means of terminal screws, and there was always the possibility of the motorman burning himself when changing batteries. There was also the chance that he would not screw up the terminals, thus causing a loss of power and the eventual burning up of the terminals. This has been changed by replacing the terminal screws with a plug type contact, so doing away with all danger from burning and poor contacts. Another bad feature was the danger of the cover to the battery box being jarred out of position and catching on timber posts, in which case the life of the motorman would be endangered. It did happen in one case, but as the locomotive was traveling slowly the motorman shut off the power and escaped serious injury. This fault has been remedied by bolting angle pieces on the battery box so that the cover could only be put on in one way, and was then held securely in place. As originally furnished, switches, fuses, and instruments were mounted on a panel in front of the motorman. This also has been changed and all exposed parts enclosed in metal boxes of substantial construction. Due to the small width of the locomotives and drifts there was always danger of part of the motorman's body extending over the side of the locomotive, and consequently danger of his being caught on timbers and badly hurt. To correct this, all locomotives are now equipped with a sheet iron guard so that the motorman, intentionally or otherwise, cannot have part of his body extending over the side.

The locomotives furnished were not equipped with charging meters but Sangamo ampere hour meters with compensation shunts which register ampere hour discharge, and on charge compensate for losses, measure proper charge, and automatically cut off charging current at the proper time, have been added. This helps materially in maintaining batteries in proper condition and reduces the consumption of distilled water. The most regular and careful inspection and attendance must be given the batteries. They should be regularly filled with distilled water, kept free from moisture and dirt, and tops well covered with vaseline to keep salts from creeping and

(Continued on Page 166)

THE MANUFACTURE OF WRITING PAPER

By H. H. HANSON, '12

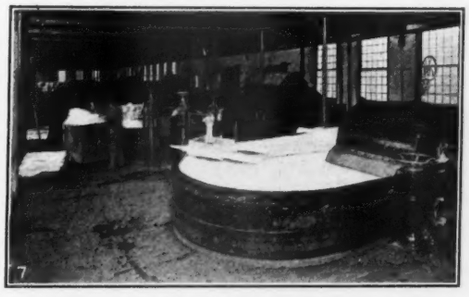
In Charge of Technical Department, Eastern Manufacturing Company, Bangor, Maine

Illustrated By Courtesy of American Writing Paper Company, Holyoke, Mass.

Writing papers may be classed in four general groups; "Bonds," "Ledgers," "Fines," and "Linen Finished Papers." Bonds are the hard, snappy papers commonly used for business letter heads, etc. Ledgers are smooth, heavy papers, used for ledgers, writing books, etc. Fines are smooth writing papers similar to bonds except that they are of a somewhat softer texture and have a higher finish; and finally, linen finished papers are those so-called "Linens" comprising the usual grades of paper.

Formerly only rags were used in the manufacture of writing papers, but during the last fifty years wood pulp has been used on an ever increasing scale. The best writing papers are still made from rags, but the majority contain large amounts of "sulphite" or "soda" pulp or both. The wood pulp paper is just as good for most purposes but lacks the strength and tone of a rag paper and deteriorates in color with age.

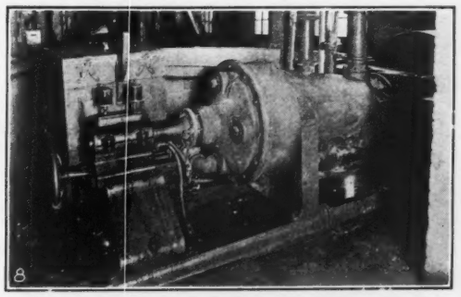
Bond and ledger papers are usually made from a mixture of rags and sulphite pulp, giving a strong sheet of paper. Fines and linens usually contain soda pulp, which is short fibered and soft, and which helps the folding quality and opacity of the paper. Filler, consisting of talc, clay, or gypsum, is added to further increase the opacity and weight. Rosin and size in the form of an emulsion is mixed with the pulp, and then precipitated on the fibres by the addition of alum, to give the paper resistance to ink penetration. All papers except blotting and filter papers contain rosin size.



THE BEATERS

Here the fibres are cut and frayed by blades on the roll and plate.

The preparation and mixing of the raw materials to get them into the proper condition for the formation of a web of paper is carried out as follows,—the desired mixture of pulp with about twenty times its weight of water, called the furnish, is put into a machine known as the beater, or beater engine. This machine is an oval shaped tub with semi-circular ends divided lengthwise by a partition called mid-feather, which, however, does not extend the full length of the machine but permits the passage of the pulp around its ends. In one of the two channels into which the vessel is thus divided, a heavy revolving roll is fitted, provided with a number of radial knives set into its periphery and parallel to its axis. On the floor of this channel immediately under the axis of the roll is a fixed "bed-plate" also provided with projecting knives, which are set parallel or at a a slight angle with those on the roll. The distance between the knives in the roll and those in the bed-plate may be altered as required, by means of an adjusting screw which lowers and raises the roll. As the roll revolves, its knives, acting as propellors, throw the stock downward between themselves and the bed-plate knives. The action mixes the stock, cuts it to the desired fibre length and "hydrates" it. The hydration of pulp is a science in itself. It is, in fact, a semi-chemical union between the cellulose fibre and water which acts very much as a jell cementing the fibres together when the sheet of paper is formed and dried. The rotation of the roll further propels the stock around the beater, so that all fibres are acted upon a number of times. It is evident that the shorter the distance between the knives of the roll and those of the bed-plate, the harsher will be the action on the pulp.



THE REFINING ENGINE

This machine contains two sets of knives which cut the stock to uniform length.

After the stock has reached the desired condition in the beater it passes through a refining engine (Jordan engine) consisting of a cone carrying radial knives which revolve inside a conical shell, completely lined with knives, set at an angle with the knives of the cone. The action of the refining engine is similar to that of a beater in so far as hydration and fibre length are concerned, but more effective and easier of control, so that the stock can be brought to just the proper condition for the different grades of paper to be made. The stock is now ready for the paper machine.

The web forming mechanism of a paper machine consists essentially of an endless belt of fine mesh wire cloth, stretched in a horizontal position over two revolving rolls about eighteen inches in diameter, the distance between the rolls varying with the size of the machine from twenty to fifty feet, and the width of the "wire" from sixty to two hundred inches. One of the rolls, called the breast roll, is set in a movable mechanism by which this whole end of the wire is made to vibrate horizontally in a direction at right angles to its length. The stock is pumped through a set of screens to remove dirt and bunches of fibre, and flows from these screens over the breast roll onto the wire. As it is carried along on the wire, the shaking motion weaves and intertwines the fibre, and at the same time most of the water drains through. The water is further removed by the action of suction boxes set immediately under the wire and in contact with it.

If any pattern or name (water mark) is desired on the paper it is produced by means of a light skeleton roll, on which the desired pattern is made by means of raised wires. The roll is set up in adjustable bearings so that it presses slightly on the moist web of paper. The roll is made to revolve by the friction of its contact with the wire, and thus leaves its impression at definite intervals.

THE PAPER MACHINE WET END

The stock passes through screens which remove dirt and knots, and then flows onto the wire.

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MONTHLY NEWS

Studying Size of Stars.—The discovery of the existence of greater stars than Betelgeuse, the giant star whose diameter was measured as 300,000,000 miles, was recently announced by Professor Albert A. Michelson. Antares, a star in the constellation of Scorpio, was named as one of the super-stars, but its exact size has not yet been determined. Other stars whose magnitude may surpass either of these are to be measured by means of Professor Michelson's new interferometer.

The Use of Helium in lighter-than-air work is soon to be put to actual test by the Navy Department when it will inflate a dirigible with this gas. Chemists who have made a study of helium welcome these tests, both in order that their own theories may be proved and that much new data may be obtained from such large scale tests. It is estimated that helium diffuses through a fabric at about seventy-five per cent of the rate of hydrogen diffusion. This fact alone is enough to make up for their difference in lifting powers. Moreover, owing to the non-inflammability of the gas it will be possible to put the engines up in the framework of the dirigible and thus secure a direct drive and increase the speed for any given horsepower. Because of the comparative scarcity of the gas it will be necessary to make improvements in the design of dirigibles to prevent the waste of the gas by valving.

Oil Shale.—Several large deposits of oil shale have recently been discovered in Tasmania, and the new fields are now being exploited. The crude oil extracted from these shales has been found to contain a high percentage of gasoline, 16 per cent being recoverable. Laboratory tests have proved that the oil can be extracted without destructive distillation and some interesting developments may be expected.

An Electric Flashlight which, instead of using a battery, makes use of an induced current, is the invention of a Massachusetts man. His flashlight resembles closely those at present on the market except that it has a projecting handle or lever which is grasped by the fingers of the holder. The back and forth motion of this handle moves a magnet inside the case in such a manner that a current is induced in the lamp circuit, causing the lamp to glow brightly. The inventor claims that such a flashlight will have a life of five years. Moreover, the light may be used under water and should prove of great use to divers.

The Alabama Power Company has obtained a temporary lease of power plant No. 2 of the Muscle Shoals project. The lease was made in order that the Alabama company might supply power principally to mills in Georgia, Alabama, and the Carolinas. Because of the drought in those states, the mills, which rely upon water power, have been forced to close down or to buy power from the Alabama company. But the latter company was also affected by the drought as most of its stations are hydro-electric plants. The plant leased is a steam plant and capable of generating 90,000 horsepower.

Recording Heartbeats.—Perfection of a device which will record the sound of a human breath or a heart beat on a steel wire from which they can be reproduced at all times, is announced by the Bureau of Standards. The device comprises the use of an ordinary telephone transmitter and a stethoscope, the current generated by the beat of the heart being "amplified and connected with a steel wire telegraphone, which has the different sounds impressed upon its spool of wire in the form of varying degrees of magnetism."

Camphor from Turpentine.—Professor P. Giraudet, of the University of Paris and Loyola University of New Orleans, has announced the discovery of a process for the manufacture of synthetic camphor from turpentine. Application has been filed for a patent which will relieve the country from the present Japanese monopoly.

An Electric Cannon based on the fact that a conductor carrying a current will travel across a magnetic field has been developed by a Frenchman. A model of the gun has been built and gives a muzzle velocity of 200 meters per second to a 50 gram projectile. Since the gun windings are used but a fraction of a second, huge amounts of current can be employed. Further details can be found in the *Revue Generale de l' Electricité.*

Australian Irrigation Scheme.—The first step in a giant irrigation scheme for Southern Australia was recently taken with the completion of the first of a series of twenty-six locks and weirs along the Murray River. The system will extend over a distance along the river of 1,066 miles; and the total expenditure will be in the neighborhood of $35,000,000. The work is being carried on by the various state governments in conjunction with the federal government of Australia.

The Power Companies of California are now in the midst of an era of construction, and it is calculated that within ten years they will have added 1,500,000 horsepower to the available electric energy in the state. Most of this increase will be brought about by the development of the water power resources of the state, for which the companies concerned have agreed to spend $600,000,000 during the next ten years. During the last two years 300,000 horsepower has been added to the available electrical energy, and at present there is 250,000 horsepower under construction. Among the new units is the natural gas burning plant of the San Joaquin Light and Power Corporation, which has a capacity of 20,000 horsepower. The largest single development is the Pit River Project of the Pacific Gas and Electric Company, which when completed will develop a total of 600,000 horsepower. One unit of this system is at present completed, and two are now under construction. Their total capacity will be over one-tenth of that of the entire system. A noteworthy feature of this project is the 220,000 volt transmission line which is 205 miles long. The Anaconda Mining Company is now manufacturing 67,000 miles of copper wire to be woven into rope-lay cable of special design made up of seven strands of seven wires each. This cable will be 0.92 inches in diameter and will be used on this transmission line.

The St. Lawrence Project.—In a recent report tendered to the International Joint Commission the cost of making the St. Lawrence River navigable to deep sea vessels from Lake Ontario to Montreal was set at $253,000,000. The improvements suggested in the report provided for a channel depth of 25 feet, a series of nine locks, 33 miles of canals, 40 miles of lake channel, and 108 miles of river channel. The recommendations also contemplated the development of a power plant capable of producing 1,464,000 horsepower, or 40% of the potential power in the St. Lawrence. The plant is to be located on a great dam at Long Sault Rapids, near Ogdensburg, N. Y.

A New Type of Submarine Motive Plant, a combination of gas and electric propulsion, will be put in three American submarines of the "V" type, two of which have just been laid down at the Portsmouth, N. H., Navy Yard. Naval engineers are watching the construction with great interest because of their expectation that improved operation of submersible warcraft will result from the new power plant. A cruising radius of 10,000 miles is said to be one possibility. These new submarines, 300 feet long, are to be equipped with four six-cylinder gas engines, giving a total of 6500 horsepower. These engines will run the boats on the surface and at the same time generate in, direct connected dynamos, current which will be used to charge the storage batteries and which will later on be used in propelling the boat while submerged through the same dynamos.

Super-Power Survey.—Adoption of a titanic scheme for consolidating the generation and distribution of electric power in the industrial region between Boston and Washington is urged in a report based upon a Federal super-power survey which was recently transmitted to President Harding by Secretary of the Interior Fall. When completed the plan will mean a saving annually of 50 million tons of coal and a reduction each year of $190,000,000 in power bills. The territory covered by the survey extends about 150 miles inland and includes the New England States, New York, New Jersey, Pennsylvania, Delaware, and Maryland. This region, which is called the "workshop of our country," contains 18 railroads, 315 electric utilities, and 96,000 industrial plants.

Adoption of the plan will mean a partial realization of the long-cherished dream of railroad electrification. About 19,000 of the 36,000 miles of main line could be electrified at a cost of half a billion dollars, but at an annual saving of fourteen per cent.

Primarily, economy of investment and operation are the two ends sought by the plan. Its outstanding features would be a great network of interconnecting transmission lines, linking up several large central steam and hydro-electric generating plants with the important distribution centers from which power would be distributed to the individual user through enormous sub-stations. While the cost of construction of such a vast network would be enormous, yet the savings and profits which members of the engineering profession claim for it would in a comparatively short time more than pay for the investment. Details of this scheme have been published in previous issues of the *Tech Engineering News*.

By means of a Catapulting Device the N-9, a two-seater hydroairplane, was recently successfully launched into the air at a speed of 48 miles per hour from a standing start. As part of a series of government tests at the Philadelphia Navy Yard the experiment proved that aircraft can be launched from battleships equipped with catapults on the turrets, and it is proposed to so equip all our battleships. The catapult consists of a grooved track fifty feet long in which a cradle is fitted. The cradle, bearing the seaplane, is pulled by an endless chain from a dead stop to full speed. As the cradle is stopped abruptly at the outer end of the track a powerful pneumatic engine quickly swings the cradle around, and hurls the plane into the air. The engines of the plane are running throughout the launching and the plane dips only a few feet after being launched. The catapult was built and the tests carried out under the supervision of Commander H. C. Richardson '06 and Commander G. C. Westervelt '08.

The Delaware River Bridge between Philadelphia and Camden is soon to be under construction, according to the plans of the Philadelphia Board of Engineers. Work is to start immediately upon the two huge caissons to be used in the construction of the piers for the bridge. The caissons will be 70 by 140 feet, built of steel and braced with the utmost care to withstand the enormous pressure involved. The two piers will rest on bed rock and from them will rise the twin towers of special construction. The towers are of the so-called elastic type, the gigantic 30-inch cables being fastened to the tops of the towers instead of passing over the towers on rollers. All stresses due to the varying loads on the bridge are taken up by the elasticity of the towers themselves, the total range of movement at the top of each tower being over three feet. This new system of construction eliminates the tremendous friction of the roller method of cable suspension, and gives more graceful lines to the towers themselves. The cables for the new bridge, the largest ever used in bridge construction, will be made waterproof by galvanizing the individual strands.

The American Navy's powerful radio station at Annapolis has been in direct communication with Japan, exchanging wireless signals with the powerful new Japanese station at Iwaki, 8,000 miles distant. Annapolis had made many previous attempts to reach Iwaki and failed; and the connection this time was obtained accidentally. A naval operator, while calling San Diego, received a faint signal on San Diego's wave, but found it to be from the Japanese station. Naval experts were astounded that the connection had been made, and now attribute it to atmospheric conditions since subsequent attempts to reach Iwaki have failed.

Oil Operators in the Duncan oil district, one of the newest fields in Oklahoma, have been forced to discontinue drilling operations for an unusual reason. A ten weeks' drought which western Oklahoma has experienced has caused a lack of water. Since it is impossible to drill oil wells without water for the boilers, arrangements are being made for laying a pipe line from a lake 40 miles distant, an enterprise which has never before been undertaken in Oklahoma oil territory.

A Chemical Solution which not only renders cotton immune to damage by vegetable rot, but also makes it absolutely fireproof, has been discovered by a Southern chemist. The yearly loss due to these two agencies is fully $250,000,000, an amount which the new discovery may save. The solution will not injure the strength of the fibre or its spinning or dyeing qualities.

Searchlight for Mt. Tamalpais, Cal.—We learn from San Francisco that Mt. Tamalpais is to have a powerful searchlight. The mountain is directly across the Golden Gate from the city and is 2,500 feet high. A sixty-inch, high intensity searchlight is to be installed on the summit, commanding an unobstructed view of the country. The searchlight is 500 times more powerful than the largest locomotive headlight, and on a clear night will pick up a ship twelve miles distant. The beam of light will be visible at a distance of one hundred miles.

The San Francisco Bridge Commission has reported itself in favor of a combined bridge, fill, and tunnel across San Francisco Bay between San Francisco and Oakland. The proposed structure will be six miles in length. The tunnel will start at the San Francisco end, run 2,500 feet at a depth sufficient to give a mean low water depth of forty feet in the channel. It will then rise up and continue in the form of an 11,500 foot steel bridge across the shoal part of the bay. A concrete pile and slab trestle, 3,600 feet in length, will carry the roadway across the deeper water at the other end of the bay. The roadway will be carried across the marsh land into Oakland on a 12,000 foot fill. Plans call for a combination vehicular and railroad structure. The greatest difficulty to be overcome is the matter of ventilating the tunnel.

The Tunnel of the Pacific Gas and Electric Company, that is to divert the greater part of Fall River through a mountain ridge to the company's power plant, lacks only 1,800 feet of being completed. The finished tunnel, which will be 10,160 feet long, is to be cement lined. Contractors estimate that 32,000 barrels of cement will be required.

The Yacht *Carnegie*, making a magnetic survey of the earth for the Carnegie Institute of Washington, is now nearing the end of its 65,000 mile voyage. In addition to the survey for practical purposes, the staff of the yacht is making observations of a purely scientific nature. These observations include the measurement of the amount of electricity in the air and of the amount of radium in sea water. The whole study is in the field of terrestrial magnetism and the chief object is to determine as closely as possible the nature of magnetism, and how its effects and changes may be measured and predicted. The *Carnegie* is an entirely non-magnetic vessel, constructed and equipped with virtually no iron, steel or other magnetic substances. She is a sailing vessel having a small auxiliary engine capable of making four knots. The engine and galley stove are of brass and the anchors of bronze. In the building of the hull only locust spikes were used.

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DOCTOR NICHOLS

It is with deep regret that we have just learned of the resignation of Doctor Nichols from the Presidency of the Institute on account of ill-health. In this noted scientist and educator we had found a worthy successor to Doctor MacLaurin, one well fitted in every way to carry on Technology traditions and place the Institute more than ever in the forefront of scientific and technical schools. Now every Technology man must feel that we are doubly unfortunate in losing him so soon, even before he had taken up his work here. His career and achievements in the fields of Science and Education are well known to all of us; to repeat them here would be superfluous.

In bidding him "Good-bye" we can only reiterate our sense of Technology's loss, and wish Doctor Nichols a speedy and complete recovery of his health and every success in his future work.

COURSE X-B

Technology has played a very large part in the development of the science of Chemical Engineering. It has led in the creation of new courses in this field. Although Course X itself is not old and Course X-A, leading to a master's degree, is younger still, the Department has recently founded a third course to be known as X-B. This new option combines in large degree the best features of the two older courses inasmuch as it includes practically every subject in the Course X curriculum as well as the regular X-A field course in The School of Chemical Engineering Practice, located at Buffalo, Bangor, and Boston. Unlike the five year course, X-B will lead directly only to the degree of Bachelor.

At present the infant of the family of Institute courses, X-B, is likely to become very popular, especially among men who cannot spend more than four years at the Institute, who, however, appreciate the value of the field training. Such a training means contact with many phases of industry which otherwise would be as a sealed book. An opportunity is afforded to rub shoulders with foremen and laborers, to gain clearer perceptions of how the wheels actually turn, to appreciate the activities and opportunities afforded by various specialized fields. Soap, steel, abrasives, paper, leather, rubber, sugar, and heavy chemicals—all are industries in which X-B men are to study. Obviously such training broadens a man's perspective more than any other experience which he might possibly have.

Unless indications are all wrong, this new course is destined to accomplish great good. It is designed to be a man-making course. It will knock many vague idealistic notions out of the embryo engineer's head and give him a practical bed-rock foundation on which to work after finding himself. The paramount value of this or any similar course lies in making this discovery of a congenial vocation possible. It seems highly probable that X-B will succeed excellently in preventing mis-fits. It is to be hoped that the apparently justifiable confidence which the Department holds out for the success of X-B is in every way fulfilled.

PROFIT AND LOSS

America lays her cards on the table! Straight from the shoulder comes Secretary Hughes' proposal for sweeping reductions in naval armament. And in record time, the representatives of all the great Powers return their answer: hearty approval, and acceptance in spirit and principle. So it would seem that the Washington Conference had, in two days, accomplished the purpose expressed in its official title. Just how complete the ultimate acceptance of America's proposal will be, and what disposition will be made of the troublesome Far Eastern questions, it is now impossible to predict, but, assuming that present indications with regard to disarmament are correct, it might be well for every good American citizen to consider the benefits which his country is expected to derive from the proposed "naval holiday."

At the outset, these benefits would be conspicuous largely by their absence. A million or more technical experts of the navy would be thrown out of work, and the capital loss of ships and navy yards would be no inconsiderable sum. But this capital loss has been taken into account as one of the principal sacrifices that America must make, and as it is predicted by business men all over the country that recovery of trade and credit, and relief of unemployment would follow closely upon the declaration of a naval truce, the temporary addition of the band of technical naval experts to the ranks of the unemployed should not be considered as a serious objection to a reduction in the size of America's navy.

The real benefit derived by America would be the ultimate saving of from 25 to 30% of the present annual expenditures of the government, or an amount exceeding one billion dollars. And the magnitude and variety of public works which could be created by an annual appropriation of one billion dollars are well-nigh inconceivable. At present, public welfare and public works are receiving only 4% of the total annual income of four billion dollars, but if a billion dollars a year could be turned into these channels of useful production, it would be possible, according to Mr. Hudson Maxim, writing in "Current Opinion," to build, with one year's allotment, a network of 25,000 miles of concrete roads in this country, five transcontinental highways from coast to coast and six running north and south; we could canalize the St. Lawrence River and thus make seaports of all the Great Lakes cities, providing a new and extremely profitable source of outlet for the products of the entire West; we could finance, with a billion and a quarter dollars, the proposed "super-power" scheme for providing the entire Eastern seaboard with hydro-electric power; and we could reclaim by irrigation vast areas of arid land in the far West. All of these projects involve the creation of new economic values many times in excess of the original investment. Turning to schemes of lesser magnitude, we read in the "Literary Digest" that forty million dollars, the cost of one modern battleship, is sufficient to endow four universities of the size of Princeton, or to build a town of 8,000 homes at an average cost of $5,000 apiece.

In counting the cost of any great forward humanitarian movement, we must not stop with its immediate effects, we must look into the future, and realize that, in the present case of disarmament, though it may at first visit hardships upon certain classes in the community, and though its beneficial effects may not become apparent for two, three, or even five years, yet in reality, those beneficial effects do exist, their existence has been appreciated by the far-sighted souls who have taken this great step for the welfare of future generations, and their final advent will be well worth the sacrifices necessary to bring them about.

THE MOTOR TRUCK VERSUS THE RAILROAD

The old question, "Who pays the freight?", is again becoming very prominent now that the public feels the after-war pinch of business depression and industrial stagnation. Because it has been convenient to unload the blame for this onto the railroads many people have not hesitated in so doing, and now business men hail the motor truck as the panacea for all ills—an admirable solution of a difficult problem!

Over a definite area, it is undoubtedly true that the motor truck is a more satisfactory carrier than the railroad. Economy of time, of terminal facilities, and of handling, are factors which make supremacy of the truck manifest. Moreover, the original capital expenditure and later the maintenace and depreciation charges are less for truck transportation. Apparently, therefore, the conclusion that the transportation problem is best handled by the motor truck is justifiable.

If this were the entire story, all would be well. Unfortunately a closer analysis reveals other facts which have a very definite effect upon the magnitude and disposition of the true cost of motor freight. The railroads must maintain an expensive right-of-way upon which they are taxed very heavily, in many cases excessively. Who pays for the right-of-way which the trucks use? In Massachusetts the general public pays more than half the cost of highway maintenance, yet the trucks derive over 90% of the benefit. In other words, motor transport agencies pass on the real cost of transportation to every tax payer of the entire state. Is it at all strange, therefore, that the interests in favor of this mode of transportation are keenly opposed to any change in the disposition of taxes which will force them to pay their just share of highway costs? It requires little imagination on their part to realize that if their rates were to be increased to cover this added cost the bite would in many cases be taken out of their competition with the railroads.

Not many years ago the jitney proved a fair-weather friend of the public when competition was on with the street railways. At present the motor truck must be put to the test. Let the motor truck owners pay for the damage they do to the roads; let the parties directly concerned pay for the freight, and if the motor truck is a better method of transportation for short or long haul freight it can and will survive and be of even greater service to the community than when subsidized by public expenditures.

GRADES VS ABILITY

Under a system where grades as determined by examinations form a standard, the question of the significance of these results is often raised. In general, the conclusion seems to be reached that men who rank high in the knowledge of fundamentals also rank high in character, judgment, and efficiency.

However, from an observation of students and graduates, it would appear that these standards are not always exact. Grades, as determined by examinations in large sections are not an absolute index of ability, because they are influenced by other factors and cannot be strengthened by any inquiry or observation on the part of the instructor, who very often has no part in correcting the papers. Similarly, grades as determined in courses based upon a mere swallowing of facts form a poor criterion, for natural ability should be stimulated by the lecturer and not quenched by a mere recital of facts which are better learned in books. Moreover, grades may be very often obtained without exceptional ability. Examinations are standardized, pet questions recur, and the resultant preparation in general gives good results.

Grades are very often obtained at too heavy a sacrifice. Such is the case of the man of average ability who becomes engrossed in nothing but study and in his specialty. This condition might be excused on the part of genius which in its enthusiasm to create must sacrifice; but for the average undergraduate who expects to go out into the industrial world, it is a mistake. This mistake is realized eventually by many graduates. It will be fatal to the man who fails to find work in his specialty and who is therefore in a hopeless quandary because of his narrow-mindedness.

Ability will very often be expressed in good grades and such should be the aim of all ambitious men. But for those who aspire to leadership in the industrial world, to the community of men of ideas and of enterprises, it is essential to broaden out by coupling good grades with good health and broad-mindedness. Student activities and athletics prepare for that real success which comes, not alone from the ability to make money, but also from the ability to render service and to live a full and well rounded life of usefulness and satisfactory achievement as an individual and as a citizen member of co-operative society.

TODAY

A few years ago, people scoffed at what they called pure science. For example, electricity was considered very interesting but of no practical use, rather as a mysterious conglomeration of phenomena than as a means to a great end. At present, it seems that we can not live without it—electricity is undoubtedly destined to be the power of the future.

The transition from the experimental stage to the practical development of any problem has always been accomplished by the engineer. It has been the engineer who has made possible not only the practical development of electricity but our very life today. It is to him the world looks for its advancement. Governments change, rulers come and go, but the engineer builds the steps upon which the world climbs upward.

Engineers are made, not born. They are the result produced when men embodied with the spirit of determination devote their attention to engineering. Their success depends in large measure on three things: their foundation or mental background acquired at college; their ability to enlarge upon their knowledge and to turn it to practical use; and finally, most important of all, upon the amount of driving power they have. It is to be remembered that the man who can drive himself is never driven.

The engineers' function in society is service, yet many students come to the Institute with the fundamental object of making money or gaining fame. This attitude does not produce a man; on the other hand, it creates the selfish self centered individual whom we all wish to avoid. A man's true success will vary directly as the extent to which he is of service to his fellow men.

Today has always been the day to accomplish things. It is in Tech that a foundation is acquired. The superstructure will depend on the breadth and depth of this foundation. It is the knowledge gained here that will make it possible to gain more and to accomplish the world's real tasks. Our opportunity is at hand. It is continually knocking. Don't turn a deaf ear. Dig in, get a vision of the future, and "follow the gleam."

India produces nearly the entire world's supply of jute. Lack of cheap labor and of suitable machines for separating the fiber have prevented its successful cultivation in the United States.

THE INTERNATIONAL TEXTILE EXPOSITION

By Special Representative of The Tech Engineering News at the Exposition

The seventh International Textile Exposition and Power Show was held this year in the Mechanics Building, Boston, from October 31 to November 5. A monument to the great strides which textile manufacture has made during the last few years, the Exposition represented the combined efforts of nearly 400 manufacturers of textiles and allied products. Thanks to the initiative of the Textile Exhibitors' Association, and to the generous support of the United States Government, there was on exhibition the largest and most varied array of textile machinery in the world. For the most part, moreover, this machinery was in full operation, in order that the manufacturing conditions might be reproduced with fidelity. To the layman, the Exposition was a complete education in the processes involved in making cottons, woolens, and silks; for every detail from sorting the raw material to weaving, dyeing, and finishing the ultimate product was minutely carried out by the most advanced methods. The purpose of the Exposition, according to Mr. E. F. Hathaway, President of the Textile Exhibitors' Association, was two-fold; to serve as a clearing house for ideas, and to afford an opportunity to the public to investigate easily the modern methods of textile manufacturers. From all reports, this intention was well carried out in both its parts.

Probably the most striking as well as the most artistic individual exhibit was that of the National Aniline and Chemical Company which occupied the entire stage in Paul Revere Hall. Here the visitor saw on the one hand the crude fabrics of the ancient civilizations, dyed with earths and vegetable extracts, and on the other hand the luxurious modern silks and other goods, dyed and printed under the supervision of designers who have the utmost skill of modern chemists at their command. The modern developments in the use of American dyes were demonstrated by the application of dye-stuffs to many varieties of materials including leather, silks, cottons, knitting yarns, and ribbons. In addition, there was a comprehensive exhibit of the dyes themselves which illustrated the advances made in recent years, including the many new shades now available. A chemical laboratory also had a place here and tests of various sorts were conducted for the benefit of the visitors. All this was framed in an Egyptian setting.

In connection with the use of alkalies and soaps for cleaning fabrics, the Solvay Process Company had on exhibition a detailed model of the equipment employed in the manufacture of their soda. It showed the raw materials in the process of interaction. Further, there was exhibited a drum of caustic, split open in order that the interesting crystalline structure might be observed.

There were also among those at the Exhibition, exhibitors of humidifying machinery, which is essential to spinning; exhibitors of water softening apparatus which can produce water sufficiently soft for treating textiles at an exceedingly rapid rate; and exhibitors of the soaps and powders used in this treatment. The best exhibit of the first of these was undoubtedly that of the American Moistening Company, an Arctic whale that spouted fine spray at regular intervals. Of the second of these exhibitors, the Permutit Company showed up among the most interesting, while Lever Brothers with a formidable array of soaps were good representatives of the third.

The Textile Divisions of the United States Bureau of Foreign and Domestic Commerce and of the Bureau of Standards were well represented at the Exposition. The former exhibited a remarkable variety of multicolored fabrics from every part of the world. There were shown among them specimens of paper clothing, closely resembling cloth, from Germany. This has shown amazing tensile strength and resistance to wear and tear.

The National Research Council and the Chemical Warfare Service exhibited samples of various substances prepared from coal tar and demonstrated with very interesting charts how war gas of numerous kinds, dyes, and medicines can be produced from the same "crude," as such basic substances as coal tar are called. Under the same auspices were shown movies of the recent tests at Aberdeen, of the bombing of the Alabama, of the manufacture of industrial alcohol, and other processes.

There were shown and announced at the Exposition many new inventions and methods; in particular, an English concern sent out information of a shuttleless weaving process.

As if in order to further emphasize the importance of the textile industries, there were held in Boston during the week a Convention of the National Association of Cotton Manufacturers, and of the new Association of Textile Chemists. The former discussed many phases of the problems confronting the textile manufacturers, while the latter definitely organized itself.

On a whole, the Exposition was extremely successful and showed that the confidence of the textile men is rising. Further, the avowed purpose of the Exposition as stated in the first paragraph was admirably carried out.

PAUL REVERE HALL DURING THE EXPOSITION

Gas that is practically incombustible is yielded by some of the wells drilled for natural gas in Oklahoma.

The Total Stress of the wires in a Steinway piano is equivalent to a weight of 72,000 pounds.

In a Study of the Smoke Nuisance at Salt Lake City an aeroplane was used to collect samples of air at different levels.

The Time of the whole of the United States east of the Rockies is regulated by three standard clocks kept in an underground vault at the Naval Observatory in Washington. These clocks are wound by electricity, and their beats are transmitted electrically throughout the observatory; the vault is never entered except in cases of emergency.

MODERN PLACER MINING

(*Continued from Page 139*)

erty that are too poor to dredge, and (2), to see that the dredge does a clean job and does not leave behind rich sand untouched. The first is planned by the management, and it depends on the interesting fact that the dredge boat travels across the property carrying its pond with it by digging on the front end of the pond and filling in behind. The pond can therefore be guided in its travels in any desired direction. In this way the valueless ground is avoided and the valuable ground is worked. The second need of guiding is the constant steering of the chain bucket digger while it is at work. This depends upon the spud and the guy

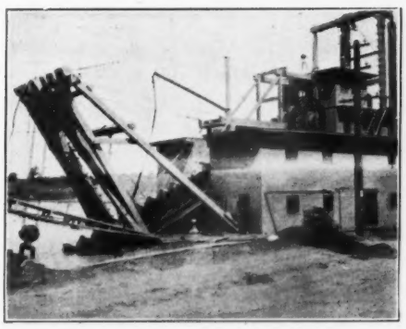


FIG. 3.—BOW END OF BOAT

Showing the chain-bucket digger, the tackle, and the gantry. The buckets are equipped with manganese steel cutting edges to dig the gravel.

lines. The spud is a heavy post, or leg, built up of iron beams, which stands vertically between guides in the stern of the boat, and by rope and pulley tackle can be forced down on the bottom of the pond and so lift the boat. This spud forms a fulcrum on which the boat can swing to right or left through a considerable angle. The guy lines are generally five in number, the bow line pulls the boat forward towards the fresh gravel, FG, the forward side lines swing the boat to one side or the other, and the stern side lines pull the boat backwards. When the boat and digger start in a new position, the digger is lowered to the lowest position and starts digging. The digger then swings forward and upward, digging fresh gravel, FG, as it goes. When it has finished its journey it is returned to the starting point, swung to right or left by the guy lines, and starts again on a new journey a little to one side of the previous journey. This is repeated over and over until the ground is worked as far as it can be from one setting of the spud, then the spud is raised and the boat moved forward for the next position. Good steering can clean up the ground very well, but poor steering can lose much gold because the last gravel that comes is the richest. The precaution is taken to dig into the floor a little way, six inches perhaps, to get the last of the gold.

Twice a day the dredge is stopped, the cocoa matting is lifted out, and the tables and launders are hosed down to catch all the remaining gravel. All this gravel is washed in a small sluice with matting in the bottom, the gold stays and the sand is washed forward. When sufficiently cleaned the coarse gold is taken out with a screen, and the fine is picked over with a magnet to remove magnetite; quicksilver may be used for cleaning the last of the gold from the black sand. It is possible to carry the treatment of the black sand further as it often contains rare minerals of some value. It can be concentrated on a Wilfley table to remove the last of the quartz sand, then dried and treated on a Wetherill magnet which yields the following minerals as the current is gradually increased: Magnetite, a valuable iron ore; Ilmenite and Chromite, either of which alone is of value; Garnet, of value for sand paper; Hypersthene, of no value; Monazite, for Welsbach lights; and finally Gold and Zircon, which are separated by pan. The Zircon has value as a fire resisting material.

Gold dredged territory is said to be spoiled for agricultural purposes; in fact dredging has been called the most complete method of de-agriculturalizing land because it puts the sand and loam at the bottom, and the pebbles and boulders at the top. In answer to this indictment we may say that the available area for dredging in a state like California is very small and need not be greatly missed; that as long as the dredging lasts, and it will be for a good while, there will be a constant stream of gold coming into the banks which has a great effect on business; and that the re-using of dredged land has been taken up by levelling it off and planting eucalyptus trees. The success in that line was, at my last information, complete.

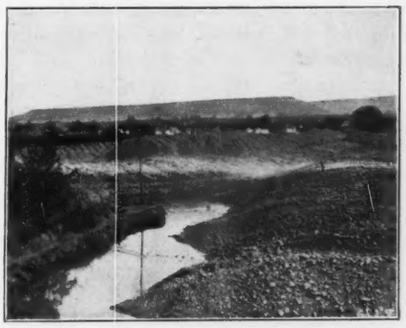


FIG. 5.—GROUND THAT HAS BEEN WORKED

The land is left practically useless for cultivation as the loam is left underneath a layer of pebbles.

A few figures taken from Longridge's "Gold Dredging" will give an idea of the results of gold dredging:

11 yards is the depth of the deposit.

21.28 cents per cubic yard was found by prospecting.

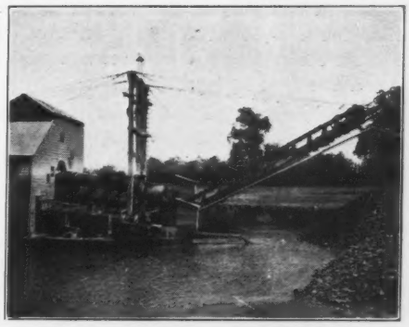


FIG. 4.—STERN END OF BOAT

Showing the screen and tables on the left, and the stacker on the right.

53,240 cubic yards to the acre to be worked.

3,240 cubic yards lost in ridges and corners.

50,000 net cubic yards to be got from an acre.

10,000,000 cu. yds. in 200 acre tract.

10,000,000 cu. yds. at 21.28 cents a cu. yd. gives gross value...	$2,218,000
Cost price of 200 acre tract ...	150,000
Cost of a 5 cu. ft. bucket dredge	65,000
Working capital	10,000
Total investment	$ 225,000

The dredge will lift about 12 to 17 buckets a minute and if it keeps running 70% of the time it will take about 17 years to work the tract.

Total value in the ground	$2,218,000
1 cent a yard left in the tailing	100,000
This leaves the amount to be recovered	2,118,000
From this we have to pay:	
The above sinking fund	$225,000
Running expenses @ $3,500 a month for 17 years	714,000
Leaving a remainder for profit	1,179,000
	$2,118,000

As these payments will be made from month to month or year to year there will be some interest accounts also to be credited.

One of the Big Expenses of a coal mine is the continual pumping of water to keep it dry. In the average anthracite mine 18 tons of water is hoisted from the mine for every ton of coal mined, and in some mines it runs up to 27 tons.

CIVIL ENGINEERING AND CIVILIZATION

(*Continued from Page 147*)

4000 B. C., the Egyptians built the pyramids. The Great Pyramid was originally 762 feet square on the base, 485 feet high, covered 13 acres of ground, and contained ninety-four million cubic feet of masonry. It would now require about 44,000 freight cars to transport this material, in one only of the pyramids, and like the temple at Karnak, all of this material was brought hundreds of miles down the Nile River.

In Babylonia, the Mesopotamia of the present, the remains of many ancient and populous cities have been uncovered, and most of what we know of this ancient civilization is due to the permanent form of construction used, preserving as it has, thousands of brick tablets on which the story of Babylon and her sister cities was written and preserved for the present. At Babylon the hanging gardens were a true example of successful engineering. They were four stories high, the top one of which contained a reservoir of water several acres in extent.

It is interesting to note that all of the seven wonders of the ancient world were structural engineering problems. These seven wonders were The Colossus of Rhodes, Diana's Temple, Mausoleum of Halicarnassus, the Pyramids, the Lighthouse at Alexandria, (300 feet high), the Hanging Gardens at Babylon, and the Olympian Zeus.

The Greeks improved, refined, and beautified all construction that they touched; but they did not contribute any new units of construction, being satisfied to use only the lintel, or beam, and the column.

The Romans are said to have been poor architects but great engineers. The principle of the arch was probably discovered hundreds of years before them, because brick sewer arches have been found in Babylonia and elsewhere, but the Romans made constant use of the arch principle, both in bridges and buildings, and made it the common property of all. They are distinguished as builders also because they perfected and constantly used a concrete which excelled everything of its kind down to the 19th century, when Portland Cement was discovered. The Pont du Gard at Nimes, France, built 19 B. C., still stands as one of the best examples of Roman work. The Pont du Gard was contemporaneous with Vitruvius, a great Roman engineer and architect, who has left an interesting and instructive account of the methods of construction used in Rome two thousand years ago, and suggestions for the training of students which are excellent, even for the present day.

Following the Romans most of the great constructive works were the great cathedrals. In the construction of these, two new and important structural elements were used and perfected. In the south of Europe, influenced by Byzantine example, the dome was now often found; as in the Sancta Sophia, at Constantinople, in the Duomo, at Florence, and finally in Saint Peter's, at Rome; while in the north where the Gothic flourished, the vaulted stone roof and buttress was adopted, as at Amiens and Rheims.

The ancients were less successful in the building of bridges. Of the few still left, practically all have masonry arches and are small in span.

From the ending of the cathedral period to the 19th century no outstanding contribution was made to the art or science of construction.

Probably iron has been known and made throughout historic times, as evidenced by its mention in Genesis, but it is only since the middle of the last century that the Bessemer and Siemens-Martin processes have made it possible to manufacture iron and steel in large quantities. Again, in 1847, an American, Squire Whipple, discovered the mathematical methods of stress analysis and these two outstanding discoveries together, made possible the great advance in bridge construction during the last seventy years.

Another noteworthy contribution of American origin, to the science of building, is the skeleton type of building now so common and distinctive in our large cities, and one which has produced almost a revolution in our city architecture. The Woolworth building, seven hundred feet high, is an example.

Modern civilization is very much a matter of transportation, since adequate transportation is probably the most important single element in making possible a democratic government of one hundred million people occupying a territory three thousand miles long. It is essential for the diffusion of education, culture, and language, and for social, economic, and industrial growth.

The United States is covered with a net work of great rivers, necessitating bridge building on a scale, both for size of structures and their number, hitherto unknown.

Captain Eads has recently been honored by having his name placed in the Hall of Fame. He was a great engineer. not alone because he was the builder of the greatest piece of bridge engineering up to his time, 1865, but quite as much because he had the vision to see that this St. Louis arch meant social, industrial, and political unity for a great country hitherto divided by the physical barrier of the Mississippi River.

From 1865, down to the present, has been a period of great bridge engineering in this country, during which thousands of reinforcing bands in the form of bridges have been thrown across all the rivers, including many more across the Mississippi.

There are three principal types of long span bridges, the Suspension, the Arch, and the Cantilever, examples of which will be briefly mentioned.

In popular estimation and in contributions to service, the Brooklyn Suspension Bridge probably surpasses all american bridges, and perhaps all in the world. It is estimated that three billion people, or thirty times every man, woman, and child in the United States, or twice all the people in the world, have passed over it.

The Hell Gate Arch, also at New York, where so many of our largest American bridges happen to be, is a railroad bridge with the largest arch span in the world. It is also distinguished by being able to carry a greater load than any other bridge of any kind, and represents altogether the finest type of American bridge engineering. The Quebec Cantilever Bridge has the longest span in the world. This bridge has had a tragic history. In 1907, the first, or old Quebec bridge, failed when about one-half completed, causing a large loss of life. This failure was caused primarily by inadequate or poor engineering design, but a contributory cause was the small appropriation for so great a work. The second or present Quebec bridge is now completed and in service, but even in this case the first suspended span was lost in the river and a second had to be built.

Although one of the greatest and most significant in many ways, this Quebec bridge failure is only one of many that have occurred in engineering construction. All failures emphasize the fact that engineering students must accept the responsibilities of their chosen profession by setting high standards of professional knowledge and accomplishment.

A great bridge is not an end in itself, it has a duty to perform as one important unit in the transportation system, and the transportation system is only one of many units in our whole industrial, social, and political fabric. It does, however, typify a high degree of development in our civilization because it is possible only because of high attainments in mathematics, in the pure and applied sciences, and in manufacture. It represents a substitution of science and reason for empiricism, a tremendous advance over the days of the pyramids.

How do they get that way?

ASK the man with the big income his "secret of success," and you will generally find that it is some copy-book maxim known to everybody.

"Be sure you are right, then go ahead."

"If anything is in your way, go over it."

"Learn something about everything and everything about something."

Trite! Anybody could give you as good advice. It simply means that success is not a problem of discovering some obscure short-cut. The path is plain enough, but only alertness, energy and self-discipline will push you along it.

All this holds a special force for you because what you do at college will influence what you do afterwards. If you start right, the chances are you will finish right.

You can begin now to earn your place in the high-salaried class. Each honest day's work in laboratory and lecture hall will bring you nearer. It will help you to master the fundamentals of your profession —so that later on you may handle problems more easily and make decisions more quickly and surely.

Then and only then, in proportion as you clear your mind of detail, can you give time and energy to those larger questions of policy in engineering, selling, management and finance, which fix the executive's market value.

Published in the interest of Electrical Development by an Institution that will be helped by whatever helps the Industry.

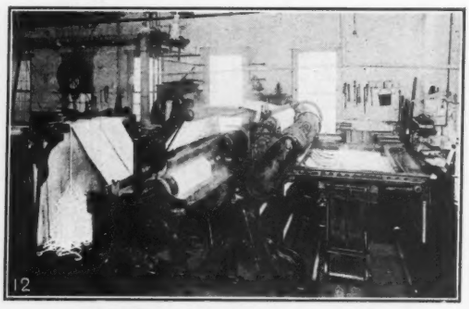
Western Electric Company

An organization whose products and services apply to all fields where electricity is used—in the power plant, in the shop, on the farm and in the home.

THE MANUFACTURE OF WRITING PAPER

(*Continued from Page 149*)

The paper web goes from the wire to an endless belt, which carries it between a series of squeeze rolls. These press out more water and the web coming from them, although still wet, has considerable strength. After passing through the squeeze rolls, the sheet is carried over drying cylinders heated by steam, where it is completely dried. The paper is now made except for finishing operations. For the cheaper grades of bonds and ledgers, these consist of running the web through a solution of glue or starch, followed by drying on another nest of drying rolls and calendering between steel rolls, or steel and fibre rolls. The glue or starch is additional size which helps the ink resistance, strength, and tone of the paper. The calendering action smooths the paper. The better grades of writing paper are run through the glue or starch as above, but instead of being dried on drier rolls, they are cut up into sheets while still wet and taken to a drying loft, where they are hung on poles and dried by hot air. This treatment allows shrinkage free from tension, and the result is a sheet of greater strength. These sheets are then calendered, or finished.



PAPER MACHINE DRY END

After drying the paper is passed through a glue bath, then cut into sheets and laid in a pile.

The amount of calendering or finish given a paper varies with the type and grade. Ledgers are very heavily calendered, and become smooth and glossy. Fines receive a medium finish, and bonds, a dull finish. Loft dried bonds, because of the low finish, retain a characteristic cockle, or unevenness of surface which all paper gets when dried without restraint. The cockle finish is highly valued in bond papers and is practically a guarantee of a high grade sheet.

Linens, after coming from the loft or paper machines, are taken to "platers" where they are given their linen like appearance. Two grades, regular linen and lawn finish, are made in addition to many specialties. Regular finish is put on by laying a sheet of iron on the table, and on top of this a sheet of linen cloth; next a sheet of paper, and then alternately linen and paper until what is known as a form, or book, is built. A form may have as many as one hundred sheets of paper, and usually has a sheet of iron for every ten sheets of paper. This form is then passed four times between heavy steel rolls, the pressure of which causes the weave to be imprinted on the paper, at the same time smoothing and polishing it so as to make a good writing surface. A form for lawn finish is made up in the same manner as is a form for regular finish, except that a sheet of zinc as well as linen is used with each sheet of paper. The form is run between the press rolls and plated as before, but the presence of the zinc gives a more exact imprint, and the paper is more highly valued.

CALENDERING AND INSPECTING

The paper is taken from the loft to the calendering machines where a smooth surface is given to it.

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RECOMMENDED ARTICLES

"Modern Steam Power Station Design," Journal of the Franklin Institute, October, 1921.

"Low Temperature Applications," Refrigerating World, October, 1921.

"Steam Superheaters, Their Design, Construction, Application, and Use," Mechanical Engineering, October, 1921.

"The History of Textiles in the New World," Dyestuffs, November, 1921.

"Modern Drop Forging Practice," Machinery, November, 1921.

"Duralumin, Its Characteristics and Uses," Aviation, October 17, 1921.

"Boston's High Pressure System," Current Affairs, October 10, 1921.

"Water Power Resources of Canada," Journal of the Engineer's Club of Philadelphia, October, 1921.

"Figuring Factory Lighting," The Jobber's Salesman, October, 1921.

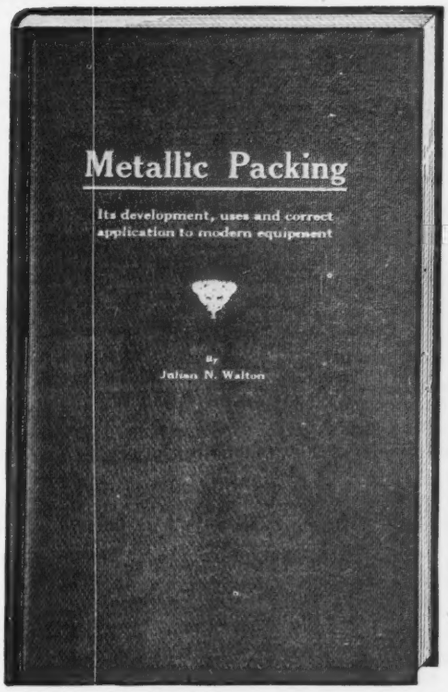
"Aerodynamics," U. S. Naval Institute Proceedings, October, 1921.

"Some Aspects of Bridge Architecture," Scientific American, November, 1921.

Completion of the Alaskan Railroad being constructed by the government between Seward and Fairbanks has been assured. The Senate passed the House bill authorizing the necessary additional expenditure on November 14.

The French Government has offered a prize of $200,000 for the best aeronautical engine suited for commercial purposes. The engine must meet certain requirements as to power and weight and be ready for test by June, 1923. There is but one condition; that the winner, if a foreigner, must permit the manufacture of the engine in France.

Professor Wallace Nernst of the University of Berlin has been awarded the Nobel prize in chemistry.



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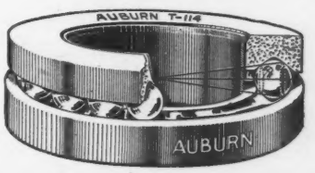

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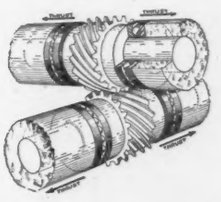

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RECENT ADVANCES IN AERONAUTICAL ENGINEERING

(*Continued from Page 143*)

point where it can be used, not only for obtaining best performances over a wide range of speeds, but also as a brake when landing, since the variation of pitch can be carried to such an extent that the direction of the thrust can be reversed. This is accomplished by making the propeller blades separate from the hub, and mounting them in sleeves which can be rotated with respect to the hub while the airplane is in flight, so changing the angle at which the blades meet the air. The mechanical difficulty of mounting the blade, so that it is able to rotate freely in the hub under all conditions and still is firmly held at all times, will be appreciated when it is realized that the centrifugal force on a single propeller blade with the throttle open often rises to over 10,000 pounds. The pilot's control for varying the setting of the propeller blades is interconnected with the throttle control so that the throttle is automatically closed as the blades pass through the neutral position and opened again as they go into reverse, thus preventing the engine from racing while the blades are set edgewise to the wind. The use of the variable pitch propeller makes it possible for an airplane to be brought to rest in about one-third the usual distance after touching the ground.

The supercharger and the variable pitch propeller have uses both in peace and in war, being no less applicable to commercial, than to military, aircraft. The leakproof tank, however, is primarily useful for aircraft likely to be attacked with machine gun fire. By the use of a rubber composition covering, the entire surface of the tank is made self-sealing, and can be riddled with bullets without losing a drop of fuel or starting a fire. Similar tanks, although with a much lighter covering, find an application in civil aviation in order to reduce the fire risk in crashes. A "crash proof" tank was recently tested by mounting it in an airplane, carrying the airplane up in a rigid airship, and dropping it from a height of about 2,000 feet with the controls set to insure a vertical dive. The airplane struck the ground at a speed of something over two hundred miles an hour, but no fuel was lost from the tank.

Great progress has been made in the last two years in the use of parachutes as a means of life-saving in airplane accidents. Parachutes have improved to such a degree that their usefulness no longer affords any ground for argument, particularly in those accidents where no skill on the part of the pilot can be of any avail, and where he should therefore prepare to "abandon ship" at once. This is most notably the case with structural failures of the airplane, and with bad fires in the air. Parachutes are virtually standard equipment on airplanes undergoing tests or being used for any work of especial hazard.

The most important single step in instrument design has been in the design of instruments for navigation in the clouds. It is a curious fact, widely commented on at the time of Sir John Alcock's flight across the Atlantic, that a pilot's senses afford him no indication as to whether he is flying in a straight path on an even keel or turning sharply with his wings tilted to an angle of bank proper for the turn. The tendency of an airplane pilot in the clouds, like that of a person lost in the woods, is to travel always in a circle. Turn indicators, most of which depend on the maintenance by means of a gyroscope of their original plane of rotation, serve to enable the pilot to hold a straight course when in the clouds or in fog.

Among the inventions thus briefly summarized it will be noted, and the same conclusion would hold true of a much more extended listing of recent developments, that most of them are designed to increase the safety and reliability of

(*Continued on Page 162*)

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Some of these things you would not use yourself, but your sister or the other fellow's sister might, you know.

Tech Branch, 79 Mass. Ave.

CONDITIONS IN ARGENTINA

(*Continued from Page 146*)

take the merchandise that he produces. This is an old story.

The Argentine securities formerly held in Europe were absorbed by the Buenos Aires market at rising quotations, as late as the middle of last year and ran into hundreds of millions of pesos. The substantial amounts of the pesos realized were used to purchase dollars to assist in the payment of a large European loan which matured with us last October, so it was not alone payment for our merchandise which advanced the dollar rate in the Buenos Aires market. Many of the mortgages on farm lands and ranches were years ago placed in foreign currency, because Europeans did not wish to run exchange risks, and the borrowers have taken advantage of the low exchanges and have paid off most of these mortgages.

You may say: "Why is Argentine exchange at such a discount if the country is so wealthy?" In January of this year the country had an exportable wheat surplus amounting to 3,500,000 tons, at that time worth $350,000,000. It has a surplus crop of 4,300,000 tons. Half of the wheat production would have been sufficient to rectify exchange. However, the Argentines thought wheat was too low in price and preferred to hold for more. Wheat now is much lower all over the world.

Commercially speaking, I was an enthusiast on the Argentine upon my arrival, and I am happy to say that I have not had to change my opinion. The Argentine is not in the class of Europe. It has no expenses for maintaining a large army, and today is the holder and owner of raw materials and foodstuffs that are badly needed by Europe, and although I have some reservations as to their recent attitude and action, after reading the complaints of Manchester manufacturers against London merchants, and after hearing the stories of our own manufacturers, I come to the conclusion that there is not such a great deal of difference. I believe that if we employ the same sort of selling for which we are noted at home; if we treat our foreign customers with the same consideration as our home customers, we will be able to hold a large share of the business. With lower prices, I see the time coming when money will be plentiful in this country, when we will be seeking investment, when we will copy Europe and help the Argentine in the development of her natural resources and her industries.

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AERONAUTICAL ENGINEERING

(*Continued from Page 160*)

flight, and that improvements in efficiency and performance are only secondary considerations. The whole effort of aeronautical engineers is directed to removing that degree of danger (a degree far smaller than the general public imagines) which still appertains to the use of aircraft, and speeding the arrival of the day when every man may take a journey by airplane with as little concern as he now feels in taking a railroad train. Already several thousand miles of routes in Europe are covered by regularly operating lines, running daily or tri-weekly services, between points as far apart as Paris and Warsaw, with an insignificant percentage of accidents. The failure to start similar services in the United States is due in part to public inertia, in part to lack of governmental support, and in part to a scarcity of landing fields; but these disadvantages must be overcome if the supremacy in easy and rapid transport, which America has long possessed, is not to be relegated to ancient history.

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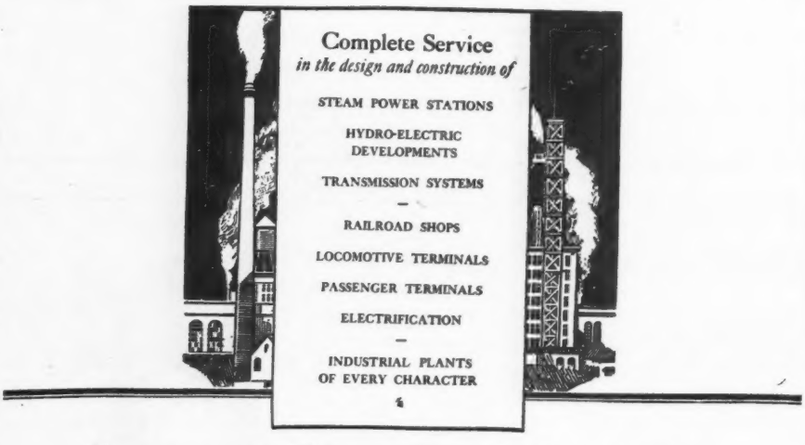
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The Code of Lighting for factories, mills and other work places of the State of New Jersey makes excellent recommendations of daylight for the proper lighting of industrial buildings.

Adequate daylight facilities through large window areas, together with light, cheerful surroundings, are highly desirable and necessary features in every work place, and they should be supplied through the necessary channels, not only from the humane standpoint, but also from the viewpoint of maximum plant efficiency.

Importance of Daylight.

The unusual attention to gas and electric lighting in factories, mills and other work places during the past few years; the perfection of various lamps and auxiliaries, by means of which an improved quality and quantity of lighting effects are obtained; and the care which has been devoted to increasing the efficiency in various industrial apparatus—all go to emphasize the many advantages and economies that result from vital and adequate window space, as a means for daylight in the proper quantities, and in the right direction during those portions of the day when it is available.

Three Considerations.

Three important considerations of any lighting method are sufficiency, continuity and diffusion, with respect to the daylight illumination of interiors. Sufficiency demands adequate window area; continuity requires (a) large enough window area for use on reasonably dark days, (b) means for reducing the illumination when excessive, due to direct sunshine, and supplementing lighting equipment for use on particularly dark days, and especially towards the close of winter days, (c) diffusion demands interior decorations that are as light in color as practicable for ceilings and upper portions of walls, and of a dull or matt finish, in order that the light which enters the windows or that which is produced by lamps may not be absorbed and lost on the first object that it strikes; but that it may be returned by reflection and thus be used over and over again.

Diffusion also requires that the various sources of light, whether windows, skylights or lamps, be well distributed about the space to be lighted. Light colored surroundings as here suggested result in marked economy, but their main object is perhaps not so much economy as to obtain results that will be satisfactory to the human eye.

Requirements for natural lighting:

1. The light should be adequate for each employe.
2. The windows should be so spaced and located that daylight is fairly uniform over the working area.
3. The intensities of daylight should be such that artificial light will be required only during those portions of the day when it would naturally be considered necessary.
4. The windows should provide a quality of daylight which will avoid a glare, due to the sun's rays, and light from the sky shining directly into the eye, or where this does not prove to be the case at all parts of the day, window shades or other means should be available to make this end possible.

As will be noticed in the above recommendations, large windows and proper diffusion of daylight are urged, in order to meet the demands of daylight lighting.

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(*Continued from Page 141*)

pass through a water seal and some sort of cooling device, best a water spray, to cool them. The whole gas production equipment should be operated under pressure so that any leakage will be outward, and not in. The fire should be operated at a low temperature, 800° to 1000° C., because under these conditions combustion goes mainly to CO_2, and very little CO is produced. This low operating temperature is also necessary in connection with the low combustion rate. On account of the positive pressure, special provision must be made for firing, but there are a number of mechanical stokers on the market which meet this condition.

As already stated, for small installations an oil burner or a small gas producer is better than a boiler, although the heat goes to waste. Gas producer conditions as to thickness and temperature of fuel bed, combustion rate, the necessity for positive pressure, etc., are the same as for a boiler.

Over the apparatus in which the evaporation of the solvent is to take place one must construct a hood. The shape and character of this covering obviously depends on the particular operation for which it is to be used. It is, however, important to have the free volume inside the machine as small as possible and to provide for positive counter current flow of the gas over the stock, so that fresh gas entering the apparatus, vapor free, will remove the last traces of solvent vapor from the stock, while the gas leaving the apparatus will be saturated with solvent, thus reducing the amount required for the operation. The apparatus should be as tight as possible although there is almost sure to be leakage at points where the stock enters and leaves the equipment. As already stated if this leakage is reasonable, it is not serious because the air can be diluted down with oxygen free gas far below the danger point. In order to minimize such leakage it is desirable to maintain the pressure of the apparatus as nearly atmospheric as possible. It is practicable to operate under plant conditions with pressures within two hundredths of an inch of water, of atmospheric. This is accomplished by using a slight excess pressure on the producer system so that the gas is delivered to the hood under slight pressure, but is drawn away from the hood by a fan which develops the pressure necessary for the rest of the system.

In starting up this sort of equipment one can arrange to sweep out all air from the apparatus before any solvent is introduced, thereby eliminating all possibility of explosion. Furthermore, in shutting down, one can wash out all residual solvent with flue gas and then the flue gas with a blast of air before operatives enter the equipment for repairs, thereby eliminating danger from toxicity.

It is believed that a wider use of flue gas in the evaporation of such solvents will greatly reduce industrial fires and explosions from this cause, and largely eliminate industrial poisoning from toxic vapors. Where properly designed to meet operating requirements, the elimination of danger can be accompanied, not by limitation but by increase in production. Fortunately, too, the best provision for safety makes possible easy recovery of the solvent which can be made to more than repay the expense incurred.

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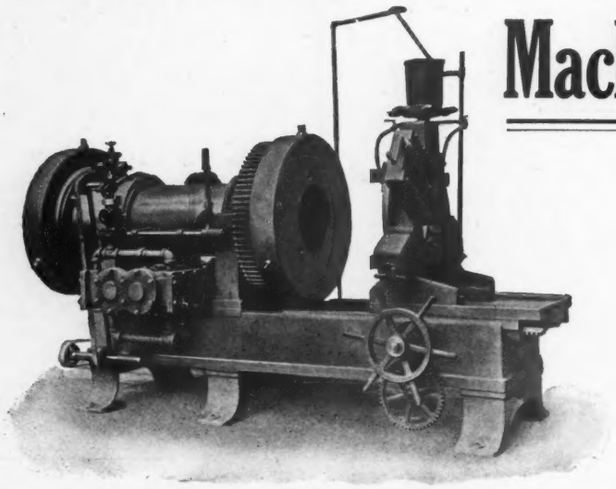

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STORAGE BATTERY LOCOMOTIVES

(*Continued from Page 148*)

shorting terminals. Batteries should be cleaned regularly and at periods of twelve to eighteen months the old solution should be poured out and all sediment removed by washing with clean old solution. Water should not be used for washing, as it removes the deposits from the plates. The batteries after cleaning should be filled with new solution and discharged down to zero. Charge should then be reversed and the batteries fully charged in the proper direction. This will bring the cells back to nearly full capacity even if before they were falling considerably below capacity. The average life of the batteries is about three years. One electrician cares for all the locomotives, making daily inspections. Charging is done on each level where locomotives are located, the locomotive barns being equipped with charging panels, water filling equipment, and a chain block with crawls for changing batteries. The distilled water is made on the surface at a cost of less than one-half cent per gallon, and approximately twenty gallons are used per day for eighteen sets of batteries. The charging voltage varies from 125 to 135 volts, and is supplied from small motor generator sets.

The average length of haulage in this mine is approximately 500 feet, varying from 200 to 3,000 feet. About ten cars are hauled per trip, the weight of a car loaded with ore being 2,250 pounds. The cars are equipped with roller bearings.

Although the cost of operation in the Butte and Superior mines has been above normal due to the poor grades, short hauls with a small number of cars, and conditions which are not conducive to a long battery life, the storage battery locomotives have proved very efficient. The Elm Orlu Mining Company and the Anaconda Copper Mining Company in Butte are also using these locomotives successfully. In the Alaska Gastineau mine at Thane, Alaska, 6-ton Baldwin-Westinghouse locomotives hauling a train of ten 4-ton cars are in use; and although the batteries used in this type are guaranteed for four years, this life has been greatly exceeded.

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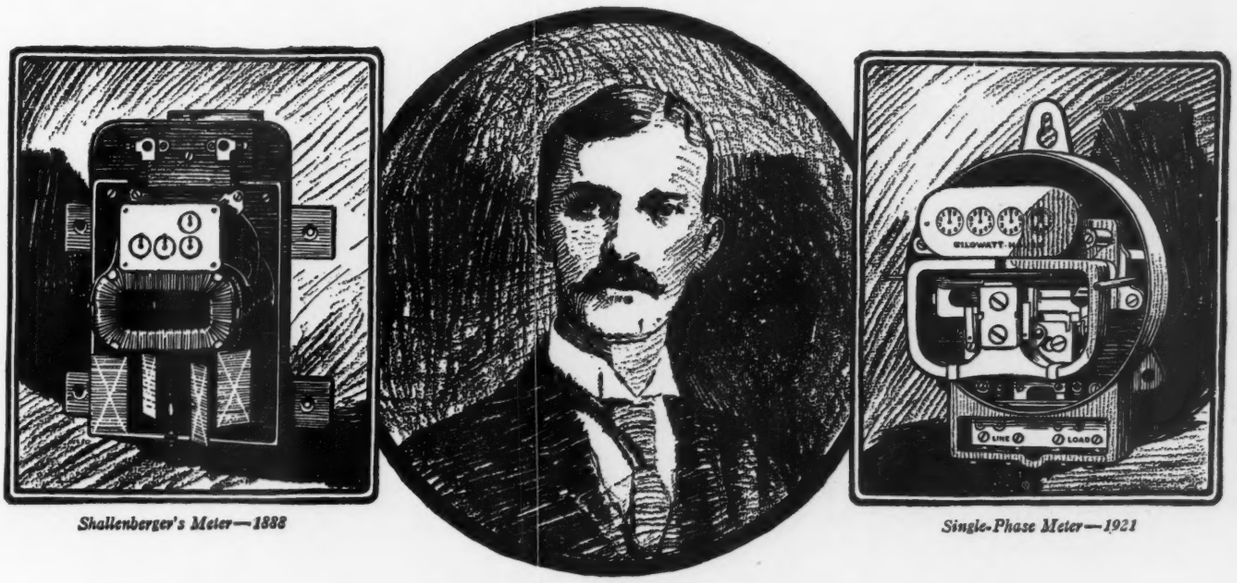

Shallenberger's Meter—1888

Single-Phase Meter—1921

Oliver B. Shallenberger

IT IS ONE THING to produce a new idea that is simply of theoretical interest. It is another to make the new idea into a commercial success.

This is the story of Oliver B. Shallenberger, and how in 1888 he discovered the principle that led him to invent the watt-hour meter, the familiar little device that makes practicable the commercial distribution of alternating current, which means 95% of all the electricity that is distributed.

Shallenberger, who resigned a Naval commission to take up his work with Westinghouse, made his discovery while experimenting with a newly devised alternating current arc lamp. His attention was attracted by the behavior of a small spring which had fallen upon the main magnet of the lamp, into such a position that the forces proceeding from both the magnet coil and the extended soft iron core affected it. And the simple little thing that he noticed was merely that the spring was slowly rotating! But to the intelligently curious observer, that was enough.

Further experiments having satisfied him that the action was caused by alternating electric currents, he set to work, encouraged by his knowledge of Westinghouse policies, to make practical the newly found principle. Three weeks of almost uninterrupted toil, and he had produced the first practical alternating current meter of the induction type—the universal type of the present time.

Thus for the first time the measurement of the quantity of alternating current passing through a line was made commercially practicable and its distribution became possible from an economic as well as an engineering point of view. In fact, the whole structure of our great power systems depends upon the accurate measurement, by millions of such meters, of the electricity used in the homes and industries of the nation. So well was Shallenberger's work done, and so complete was his conception of the possibilities of his discovery, that for more than thirty years his fundamental idea has been in use in many and various forms.

The encouragement which Westinghouse has always given to new ideas, and the judgment with which they have been evaluated, are nowhere better exemplified than in this story of the alternating current meter.

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Graduates of colleges, and in general all applicants presenting certificates representing work done at other colleges, are excused from the usual entrance examinations and from any subjects already satisfactorily completed. Records of the College Entrance Examination Board, which holds examinations at many points throughout the country and in Europe, are also accepted for admission to the Institute.

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A certain large manufacturer of hard candy experienced great difficulty in running his plant on wet days. The candy would not mould; it stuck to the hands of the girls who packed it, to the paper it was wrapped in, and generally raised so much trouble that, on days when the humidity was high, it was less of a loss to shut down the plant than to try to operate it.

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problem. Today in this candy factory every day is an ideal working day.

The factory is as free from bad outdoor weather conditions as it would be if it were on another planet.

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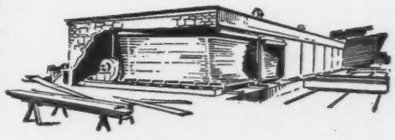
Large manufacturers of a well-known product, who needed so much lumber that they had already purchased their own forest land, used to ship the untrimmed, unseasoned wood north for seasoning. After seasoning it for more than a year, they would trim it and make it into the finished products.

We installed a system whereby the lumber is seasoned where it is cut. Then it is trimmed there. Freight charges are saved, because no waste wood is shipped north; storage charges are reduced, because large amounts need not be stocked up; and manufacturing costs are lowered, because the raw material is made into the finished product in a shorter time.



We maintain a large staff of engineers who are ready to try to solve your manufacturing problems by the use of air. These men have a collection of data to rely upon which took us more than sixty years to compile. If you wish to know how air has been or can be used in your business, write, phone, or wire for specific information. State the business you are engaged in. We will send you bulletins which cover the uses of air in your business. Or, if you specially request, we will have one of our representatives visit your plant and go over the problem with you.

B. F. STURTEVANT COMPANY

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STURTEVANT BRANCH OFFICES

ATLANTA, GA.
306 Walton Bldg.

BOSTON, MASS.
555 Mass. Trust Bldg.

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100 Bedford Ave.

CHICAGO, ILL.
530 So. Clinton St.

CINCINNATI, OHIO
604 Provident Bank Bldg.

CLEVELAND, OHIO
330 Guardian Bldg.

DALLAS, TEXAS
3411 Knight St.

DETROIT, MICH.
406 Marquette Bldg.

HARTFORD, CONN.
36 Pearl St.

KANSAS CITY, MO.
710 Mutual Bldg.

LOS ANGELES, CALIF.
411 Hollingsworth Bldg.

MINNEAPOLIS, MINN.
804 Met. Life Bldg.

NEW YORK, N. Y.
52 Vanderbilt Ave.

PHILADELPHIA, PA.
135 No. Third St.

PITTSBURGH, PA.
711 Park Bldg.

ROCHESTER, N. Y.
1024 Granite Bldg.

ST. LOUIS, MO.
2086 Railway Exchange Bldg.

SALT LAKE CITY, UTAH
818 McIntyre Bldg.

SAN FRANCISCO, CALIF.
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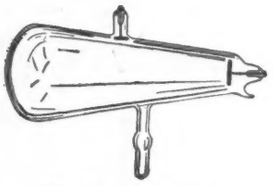
1105-1106 White Bldg.

WASHINGTON, D. C.
1006 Loan & Trust Bldg.

B. F. STURTEVANT CO. OF CANADA, LTD.,
GALT, ONT.

MONTREAL
404 New Birks Bldg.

TORONTO
210 Lumsden Bldg.



Hittorf or Crookes Tube

How Were X-Rays Discovered?

SIR James Mackenzie Davidson visited Professor Roentgen to find out how he discovered the X-rays.

Roentgen had covered a vacuum tube, called a Hittorf or Crookes tube, with black paper so as to cut off all its light. About four yards away was a piece of cardboard coated with a fluorescent compound. He turned on the current in the tube. The cardboard glowed brightly.

Sir James asked him: "What did you think?"

"I didn't think, I investigated," said Roentgen. He wanted to know what made the cardboard glow Cnly planned experiments could give the answer. We all know the practical result. Thousands of lives are saved by surgeons who use the X-rays.

Later on, one of the scientists in the Research Laboratory of the General Electric Company became interested in a certain phenomenon sometimes observed in incandescent lamps. Others had observed it, but he, like Roentgen, investigated. The result was the discovery of new laws governing electrical conduction in high vacuum.

Another scientist in the same laboratory saw that on the basis of those new laws he could build a new tube for producing X-rays more effectively. This was the Coolidge X-ray tube which marked the greatest advance in the X-ray art since the original discovery by Roentgen.

Thus, scientific investigation of a strange phenomenon led to the discovery of a new art, and scientific investigation of another strange phenomenon led to the greatest improvement in that art.

It is for such reasons that the Research Laboratories of the General Electric Company are continually investigating, continually exploring the unknown. It is new knowledge that is sought. But practical results follow in an endless stream, and in many unexpected ways.

General Electric Company

General Office **Schenectady, N. Y.**

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